Environmental Impact Assessment for Agriculture Development in Gdh. Hudhuvaarulaa, Menthanhoo Golhaalaa and Dhoonirehaa, Gaaf Dhaalu Atoll

PREPARED FOR
Hummingboy Farms PVT. LTD

Prepared by:
Mahmood Riyaz PhD (EIA03/07)
Mohamed Shiham Adam PhD (EIA 01/07)

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Acronyms used in the text

BOD	Biological Oxygen Demand
BOH	Back of the House (all the utility function and its services on the resort)
COD	Chemical Oxygen Demand
FOH	Front of the House (guest rooms, reception restaurant, arrival pavilion etc)
DNP	Department of National Planning
EPA	Environmental Protection Agency
EPAA	Environmental Protection and Preservation Act
MEE	Ministry of Environment and Energy
MoFA	Ministry of Fisheries and Agriculture
MoHE	Ministry of Housing and Environment
MoT	Ministry of Tourism,
MSL	Mean Sea Level

Declaration of the Consultant:

I certify that the statements made in this Environmental Impact Assessment are true, complete and correct to the best of my knowledge and available information at the time of writing this report.

Mahmood Riyaz (EIA03/07)
August 2016

Declaration of the Proponent

HUMMINGBOY FARM

Declaration of the Proponent:

As the proponent of the proposed agriculture development project in Gdh. Hulhuvaarulaa, Menthandhoo Golhaalaa and Dhoonirehaa, Gaaf Dhaalu, I guarantee that I have read the Environmental Impact Assessment report thoroughly and that to the best of my knowledge all information provided here is accurate and complete.

David Anderson

For

Hummingboy Farms Pvt.Ltd

M. Kudaneyomatheege • K. Male', 20315, Republic of Maldives • T: +44 7801 653 917 • info@hummingboy.com • www.hummingboy.com

1 ސާރާ ޚުލާސާ

1- މިއީ ހުވަދު އަތޮޅު ދެކުނުބުރީގެ ގައްދޫ އާއި އެއްކޮށްގެއްލުމުގައި އުޅެނީގެ އަތޮޅުން ޓޫރިސްޓް ހަމަޖެ ޖަހަނަމުގައިވާ ހުޅުވާލުވާ، ފުރަތަމަ ގޮތުގައި ޕްރޮޖެކްޓް އަދި ޑިޒައިނާގައި ދަނޑުވެރިކަން ތަރައްޤީކުރުން ހިންގުމުގެ ސަރަޙައްދު ތިމާވެއްޓަށް އަސަރު ފޯރާގޮތުގެ ބަޔާން ވަޒީފާގެ ހަމިންގްބޯއީ ފާމްސް ޕްރައިވެޓް ލިމިޓެޑް. ގ ވަށާފަށް ތަރައްޤީކުރި ތިމާވެއްޓަށް އަސަރުކުރާ މިނިވަން ބައްޓަނުގެ (އީއައިއޭ) ރިޕޯޓް. ހުށަހެޅުއްވާ ޕްރޮޖެކްޓްގެ އެޑްމިނިސްޓްރޭޓިވް ހަވާލާ ޕްރޮޖެކްޓް ... ދެވަ. ހުވަދު އަތޮޅު، ފުރަތަމަ ޑިޒައިނާއި ދަނޑުވެރިކަން ތަރައްޤީ ކުރުމަށް ހުޅުވާލާ ހޯދުމުގެ ވުޒާރާ ތަރައްޤީގެ ބާޒާރުކުރާ ތަނެއް ގޮތުގައި ހިފުން ޙަރަކާތް ފަތުރުވެރިކަމުގެ ބޭނުމުގައި ބައެއް ތަނެއްގައި، ވިލާގެއި ތަކެތި ތަކުރު ބަނދަރުގެ ކުރުމާއި، ދަނޑު ހުޅުވާލުމަށް ކުރުމަށް ހުރިހާ ވެއްޓަށް ނެގުމަށް ރަށްބިން ކަހާލުމުގެ ތަރައްޤީ ދަނޑުވެރިކަމާއި ދިރިއުޅުން ތަކެތި ބާވަތްތަކުގެ ގުދަނު ބޭނުން އަދި ހުރިހާ ބަދަލު ... ނުކުތުމުގެ ފާހަގަ ކުރުމުގެ ޕްރޮޖެކްޓްގެ ބޭނުމަކީ ރަށުގެ ގުދަނުތަކުގެ ބަދަލުގައި ހޯދުމަށް ...، ދަނޑުވެރިކަމުގެ ބާވަތްތަކުގެ ބާޒާރުކުރުމުގެ ފުރުޞަތު ބޮޑުކުރުން، ގައުމީ ގޮތުން މާލީ ބަދަލު ... ހަލާކު ... ފޯރުކޮށްދިނުމަށް ތިމާވެއްޓަށް ... (93/4) ބާރުއެޅުން ތަރައްޤީގެ މަޝްރޫޢުތަކުގެ ފުރުސަތު އެހެން ސަރަޙައްދު ތިމާވެއްޓަށް އަސަރުކުރާ މިންވަރު ވަޒަންކުރުން ކުރެވޭނެއެވެ.

2- މިޕްރޮޖެކްޓްގެ ޖުމްލަ އަގަކީ ގާތްގަނޑަކަށް 10.2 މިލިއަން އެމެރިކާ ޑޮލަރެވެ. މިޕްރޮޖެކްޓް ހިންގުމަށް ހަމަޖެހިފައިވަނީ ފިނޭންސް ބައިވެރިވުމުގެ ގޮތުގައެވެ. މިޕްރޮޖެކްޓްގެ ސަރަޙައްދު ސިނާ ގުޅިގެން ގުޅުއްވާ ... ގަވާއިދާއި އެއްގޮތަށް އެކުލަވާލާ ... ދިރިއުޅުމުގެ ޚިދުމަތާއި ޚިދުމަތުގެ ބޭނުންކުރުމެވެ.

3- މި މަޝްރޫޢުގެ ފުރަތަމަ ފިޔަވަހިކަމުގައި ހިމެނޭ ރަށުގެ ބިމުގެ 425 މީޓަރު ދިގު، 15 މީޓަރު ފުޅާ ބަނދަރާއި 50x50 މީޓަރު ބަނދަރު ހެދުމާއި، 3 ހެކްޓަރު ގެ ބިމުގައި ހައިޑްރޯޕޯނިކްސް ނިޒާމުގެ ބަނދަރު ގުދަނު ތަކެތި ... ދަނޑުވެރިކަމުގެ ބާވަތްތައް ... ހެދުން ...، ... ބައްޓަން ... ގުދަނު ... ބާއްވާ ... ޖެނެރޭޓަރ ... 4 ހެކްޓަރުގެ ބިން ސާފު ކުރެވޭނެއެވެ.

4- ދެވަނަ ފިޔަވަހިކަމުގައި، އިތުރު 2 ހެކްޓަރުގެ ބިން އަދި ފުރަތަމަ ފިޔަވަހިން ކަނޑައަޅާ 4 ހެކްޓަރުގެ ބިން ސާފުކުރެވޭނެއެވެ. ... މި މަޝްރޫޢުގެ ޖުމްލަ ޕްރޮޖެކްޓް ސަރަޙައްދު 10 ހެކްޓަރުގެ ދަނޑުބިން ތަރައްޤީކުރުން ... ހިމެނެއެވެ.

5- މިމަޝްރޫޢުގެ ދަށުން މައިގަނޑު ގޮތެއްގައި އުފެއްދުމަށް ބަގީޗާ ކުރުވިފައިވާ ޓްރޮޕިކަލް ފިނި މާޙައުލުގައި ހެދޭ ބާވަތްތައް އުފެއްދޭ ތިޖާރީ ގޮތުން ކުރުމަށެވެ. މިގޮތުން މައިގަނޑު ގޮތެއްގައި ހައްދާނީ ޓޮމާޓޯ، ސްޓްރޯބެރީ، ރާސްބެރީ، އަދި ބެލް ޕެޕަރ އެވެ.

6- މިރިޕޯޓު ތައްޔާރު ކުރެވިފައިވާނީ 2012 ވަނައަހަރު މިނިސްޓްރީ އޮފް އެންވަޔަރަންމަންޓް އެންޑް އެނަރޖީއިން ގެޒެޓްކޮށްފައިވާ ތިމާވެއްޓަށް އަސަރު ފޯރާ މިންވަރު ބެލުމުގެ ޤަވާއިދާ އެއްގޮތަށް ތައްޔާރުކުރެވޭ ރިޕޯޓްތަކުގެ މަތިންނެވެ. ގދ. ހަވޯދިގާ، ފިޔޮރީ، ގައްދޫ އަދި ދޫނިދޫގައި ދަނޑުވެރިކަން ތަރައްޤީކުރުމަށް ތިމާވެށީގެ ގޮތުން ފެންނަ ސަމާލުކަން ދެވިފައިވާ ގޮތްތަށް މިރިޕޯޓުގެ ތެރޭގައި ބަޔާން ކޮށްފައިވާނެއެވެ. މިރިޕޯޓްގައި ހިމަނާފައިވާ މަޢުލޫމާތު، ސާވޭ އަދި ބޭސްލައިން ސާރވޭގެ ތެރެއިން ހޯދުނު ނަތީޖާތަކާއި، ދަނޑުވެރިކަމުގެ ޕްރޮޖެކްޓުގެ ބައިތައް ގެންގޮސް ތަންފީޛު ކުރުމުގައި ތިމާވެއްޓަށް ކުރާ އަސަރު ކަނޑައަޅައި، އެ އަސަރުތައް ކުޑަކުރުމަށް ކުރަންޖެހޭ ކަންތައްތަކާއި ތިމާވެށީގެ ގޮތުން ދަނޑުވެރިކަމުގެ މަޝްރޫއު ބެލެހެއްޓުމުގެ ޕްލޭން ހުށަހަޅާފައިވެއެވެ.

7- ގުޅިގެން ކުރިއަށްގެންދާނެ ދަނޑުވެރިކަމުގެ މަސައްކަތްތައް ހިނގާނީ ގދ. ހަވޯދިގާ، ފިޔޮރީ، ގައްދޫ އަދި ދޫނިދޫގައެވެ. މިއީ ހުސްރަށް އަދި ރަށުތަކުގައި ބިން ކުޑަ ދޮރޯށި ހުރި ރަށްތަކެކެވެ. މިރަށްތަކަކީ އެއްފަދަ ގޮތަކަށް އުފެދިފައިވާ ބޯހިޔާވަހިކަމާއި ޖަންގަލިތަކުން ފުރިފައިވާ 5 ރަށެކެވެ (ހަވޯދިގާ، ފިޔޮރީ، ގައްދޫ، ދޫނިދޫ އަދި ކާޑެއްދޫ) އަދި މިރަށް ވަރަށް ކުޑަ އަދި ވަށްކޮށް ގޮތުގައި ހުރެއެވެ. މިރަށްތަކުގެ ބިމަކީ ގދ. ހަވޯދިގާ، ފިޔޮރީ، ގައްދޫ އަދި ދޫނިދޫ ކުރިން ދަނޑުވެރިކަން ކުރެވިފައިވާ ރަށްތަކެކެވެ. އަދި ދޫނިދޫގައި ދަނޑުވެރިކަން ކުރެވެއެވެ. މިރަށްތަކުގެ ބިމުގެ ފުޅާމިން ވަރަށް ގިނަ ދިގުމިނާއި ފުޅާމިނެވެ. މިފަދަ 10 ހެކްޓަރުގެ ބިމެއް ދަނޑުވެރިކަމަށް އަދި 1-1.8 ހެކްޓަރު ވަރަކަށް ފުޅާކަމެވެ. މިރަށްތަކުގެ ބޮޑުމިން 14.5 ހެކްޓަރު ވަރަށް ބިމެވެ.

8- މަޝްރޫއު ގެ މަސައްކަތް ހިންގުމަށް ހަމަޖެހިފައިވާ ހަވާލު ރަށްތަކުގެ ގޮސްކަށަ ބޯހިޔާ ފިޔޮރީ، ގައްދޫ އަދި ދޫނިދޫގެ ގޮސްކަށަ ހަވާލުކުރެވިފައިވާ ގޮތުން ހިފުމަށް ހުރިބިމަކީ ތިބާވަތުގެ އުފެއްދުންތައް ބޭނުން ކުރުމެވެ. ގދ. ހަވޯދިގާ އާއި ދޫނިދޫގައި ބޮޑަށް ހެދޭ ބާވަތްތަކުގެ ބާވަތްތައް ހިފާ ގަސްތައް ހައްދައިގެން އެކި ބާވަތްތަކުގެ ގަސް ބާވަތް ހެދޭނެ ގޮތް ފަރުމާކުރެވޭ ގޮތް ބަލައިގެން ހުރިގޮތް ދެނެގަތުމަށް ރިސާޗެއް ފެށިފައިވެއެވެ. ބިމުގެ ގޮސްކަށަ ދަނޑުވެރިކަމުގެ ބަޔަކު ދަނޑުވެރިކަން ކުރެވޭ ބިމެއް ދޫކުރެވިފައެވެ. ދަނޑުވެރިކަމަށް ފޮނުވާ ބާވަތްތަކުގެ ގޮތުން ހަމަ ދޫކުރަން ބޭނުން ގިނަވާނެއެވެ. ދަނޑުވެރިކަމަށް ފިޔޮރީ ގައްދޫގެ ބިމުގެ ދޫކުރުމަށް ހުރި ބިމުގެ ބަޔަކީ ދަނޑުވެރިކަމަށް ފަހި ބިންކަމުގައި ބެލެވެއެވެ. ދަނޑުވެރިކަމަށް ބޭނުން ކުރެވިދާނެ ބިމަކީ ގައްދޫ، ފިޔޮރީ އަދި ދޫނިދޫގެ ބިމުގެ ދަނޑުވެރިކަމަށް ޚާއްޞަކުރެވިފައިވާ ބިމުގެ ބައެކެވެ (ގައްދޫ، ފިޔޮރީ، ދަނޑުވެރިކަމުގެ ބިމުގެ ބައެއް) ދަނޑުވެރިކަމަށް ބޭނުންކުރެވޭ ބިމުގައި ވަރަށް ގިނަ ބާވަތްތަކުގެ ގަސްގަހަގެހި ހުރެއެވެ. ގދ. ހަވޯދިގާއާއި ދޫނިދޫގައި، ދޮންކެޔޮ ގަސް، ކާށި، ކަޅުހުތް، ފަތްގަސް، ބަނބުކެޔޮ އަދި އެހެނިހެން ގަސްތަކެވެ. ބިމުގެ ދަނޑުވެރިކަމުގެ މަސައްކަތްތަކުގައި ބޭނުން ކުރެވިދާނެ ބިމެއް ފެނެއެވެ. މިބިން ދަނޑުވެރިކަމަށް ބޭނުންކުރުމުގައި ބިމުގެ ގޮތް ބަލައިގެން ދަނޑުވެރިކަމުގެ ގޮތް ބަދަލުވެދާނެއެވެ. ދަނޑުވެރިކަމުގެ ހައްދާ ބާވަތްތައް ގަސްގަހަގެހީގެ ގޮތުން ވަކިން ބެލޭނެއެވެ. އަދި ދޫނިދޫގެ ހައްދާ ބާވަތްތަކުން ގިނަ ބާވަތް ގަސްތަކެއް ހުށްޓުން ހިފާނެއެވެ. ގދ. ހަވޯދިގާގައި ހުރި ވަރަށް މަދުބާވަތް.

9- ދަނޑުވެރިކަމުގައި ބަސް ހުރިހާ ސަރަހައްދުގެ ބޮޑުމިނަކީ 251،092 އަކަ މީޓަރު، އަދި ގައްދޫގައި 150،588 އަކަ މީޓަރު ފިޔޮރީގައި 104،027 އަކަމީޓަރު އަދި ދޫނިދޫގައި 52،336 އަކަމީޓަރެވެ. މިމަޝްރޫއު ގެ ބޮޑުމަން ދަނޑުވެރިކަމުން 73664 އަކަމީޓަރު، ފިޔޮރީއިން 21000 އަކަމީޓަރު، ގައްދޫ އިން 21000 އަކަމީޓަރު އަދި ދޫނިދޫއިން 1388 އަކަ މީޓަރުގެ ބިން ސާފު ކުރެވޭނެއެވެ. މިއީ ދަނޑުވެރިކަމުގެ ގޮސްކަށަ ބިމުގެ، 29%، ފިޔޮރީގެ 20%، ގައްދޫގެ 13% އަދި ދޫނިދޫގެ ގޮސްކަށަ ބިމުގެ 2% އެވެ.

10- ދިރަމަތުރަން ހިމެނޭ ފަޅާއި ފަރު އަދި މޫދުގެ މާހައުލު އުފެދިފައިވާ ގޮތްތަކަށް ބަލައި މައިގަނޑު ފީޗަރތަކުގެ ސަރަހައްދު ތަކަކަށް ބަހާލެވިދާނެއެވެ. އެއީ އިރުމަތީ ފަރާތުގައި ފަޅުގެ ކުރިއަށް ބޮޑު ހިނގާ ސަރަހައްދުގައި، ފަޅުގެ ފަރުމަތިން ގިނަ އަތިރިމަތިން ބަލާ ވަށައި ގާ ހުރި ސަރަހައްދުގައި، މޫދުގެ ގުރާނު ސަރަހައްދާއި، އެތެރެފަރާތުގެ ވިނަގަސް ހުރި ގޮތުގެ ފަރާތާއި، ރަށުގެ ދުވަސް (ގޮވާމަތީގެ އިރުމަތި ގޮނޑުދޮށް ފަރާތުގައި އަދި ދެކުނުފަރާތު ހިކަށި) ދުއްވާ ފަރާތް ތަކުން ހުރި ރާޅު އަރާ ދުވަސް ފަރާތާއި ސަރަހައްދުތައް. މިތަނުގެ ފުރާނަ ދިރުމާއި މަސްވެރިކަމާ ބެހޭ ތަފާސްހިސާބު ދިނީ ބޭރު ސަރަހައްދުތަކެވެ.

11- ހުށަހަޅާފައިވާ ޕްރޮޖެކްޓުގެ މަސައްކަތްތަކުގެ ސަބަބުން ތިމާވެށްޓަށް އަސަރުކުރާނެ މިންވަރު ބޮޑުކަން ބަލައި އިތުރުކުރުމަށް ގޮތްތައް އުފެއްދުމަށް ކުރެވުނެވެ. މިގޮތުން އިތުރުކުރުން ގޮތްތައް އަދި އެއްވެސް ބެލުމަށް ތިމާވެށްޓަށް އަސަރުކުރާ މިންވަރު ބޮޑުކަން ދެނެގަތުމަށް ބޭނުން ކުރެވުނު ބަޔަކަށް ބަލައިލެވުނެވެ. މިގޮތުން ބޭރުގެ މަސްވެރިކަމުގައި (ހަރަދު) އެންމެ ދިމާވާ ހިނގުމުގެ ހުރިހާ ފަރާތާ މަޝްވަރާ ކުރެވި ޕްރޮޖެކްޓުގެ ތިމާވެށްޓަށް ކުރާނެ އަސަރު ކުޑަކުރުމަށް ކުރެވޭނެ ކަންތައްތަކާ ބެހޭ ގޮތުން މަޝްވަރާކުރެވުނެވެ. އަސަރު ހުރި ފަރާތްތަކުގައި (އާބާދީ) އެންމެ މި ޕްރޮޖެކްޓުގެ ތިމާވެށި ބޮޑު ސަބަބުން ދިމާވާނެ ގެއްލުން ސަރަހައްދުގެ ބެލެހެއްޓުމުގައި ބަހައްޓަން ބޭނުންވާ އަސަރު ކުޑަކުރާ މިންވަރެވެ.

12- ޕްރޮޖެކްޓުގެ ބަރަބަރު ކުރުމުގެ ތިމާވެށީގެ ނިންމުމަކީ ސަރަހައްދު ތަރައްގީކުރެވޭ ކަނޑު ހިނގާ ބޭނުން ކުރާނެ ގޮތުގެ ސަބަބުން ގެއްލުން ހުރި ގޮތްތަކަށް ޖަރީމާ އެއްސަވާ ނުވަތަ އަތުވެދާން ބައްލަވާ ފަރާތްތަކުން ދިމާވާ ގެއްލުން ވަރަށް ބޮޑު މަސައްކަތްތަކެއް ކަމަށް ފާހަގަކުރެވެއެވެ. އަދި އެކަންކަން ދަތިކޮށްފައި ނުވާ ބައިތަކުގައި ނަގާ ފަރާތްތަކުން ހަމަޖެހިފައިވެއެވެ. ބިމާއި ރަށް ބޭރުގެ ޕްރޮޖެކްޓުން ބޭރުކުރާ ކުނި ސަރަހައްދުގެ ތިމާވެށީގެ ކުރިޔަށް ނުރައްކާވާ ފުރަތަމަ ބައްޓަން ބަހައްޓަން ނިންމާ ސަރަހައްދު ތަރައްގީކުރުމުގެ ހުރިހާ ޓާރގެޓް ޖާގަ ބޭނުމަށް ދިރުމުގެ ތިމާވެށީގެ ޖަރީމާ ހިނގާ ފަރާތްތަކުގެ ހިތްވަރުދިނުމަށް މަސައްކަތްތަކެވެ. ތިމާވެށީގެ ފާހަގަކުރެވުނު ކޮންމެ ކަމެއް ބެލެހެއްޓުމުގެ ހިންގާނެ ގޮތެއް އިރާދަކުރެވޭނެ ފަރާތްތަކުގެ ފަރާތުން ދަތިކޮށްފައިވާ ފަރާތްތަކުން ހިތްވަރުދިނުމަށް ކަމަށް ފާހަގަކުރެވެއެވެ. ޕްރޮޖެކްޓުގެ ބަރަބަރު ނަހަމަ ހިނގާ މަސްވެރިކަމުގެ ބެލެހެއްޓުމުގައި މަސައްކަތްކުރުމަށް މަޝްވަރާ ކުރުމަށް (ކޮންމެ އަދި ހުށަހެޅުމެއް) ދެނެގަތުމުގެ ތަފާސްހިސާބު ނެތް ގޮތެއް ބޭނުންކުރާ ކުރިއެރުމުގެ ސަރަހައްދުގެ ތިމާވެށި ރައްކާތެރިކޮށް ގެނެސް ބެލެހެއްޓުމަށް ހަދާފައިވާ ފާހަގަކުރެވުނު ކަންތައްތަކުގެ ފިޔަވަޅު އަޅަމުން ބެލެހެއްޓުމުގެ ތިމާވެށި ނިންމުމުގެ ފިޔަވަޅު ހޯދުމަށް މަސައްކަތް ކުރުމަށް ބައިވެރިކުރެވުނެވެ. ދެވަނަ މިގޮތުގެ ސަރަހައްދުގެ ތިމާވެށީގެ ދިރުމަށް ފަރާތްތަކުން ކުރިއަށް ގެންދެވިފައިވާ ކަންކަމެވެ.

13- މި މަޝްރޫއުގެ ދަށުން ކުރަންހުރި ހުރިހާ ކަމެއް ބެލެހެއްޓުމުގެ ބަރާބަރު ކުރަންޖެހޭ ކަންތައްތަކާއި، ދަތިތަކާ ތިމާވެށީގެ ބެލެހެއްޓުމުގެ ގޮތުން ގޮސް ކުރެވިފައިވާ ކަންކަން މިދިޔަ ކަމަކަށް ފަރުވާކުރާގޮތަށް ހަމަޖެހިފައިވެއެވެ. މިދުވަސް ކުރީގެ ހުރިހާ ގޮތަކަށް ގޮވާމުގައި ދަށު ނޯޓު ހުށަހަޅާ ހިސާބުގެ ކާނާގެ ބާވަތްތަކާއި ބަދަލު ކުރާ ބައިވެރިވުން ބައެއް ގޮތުގައި ކުރަން ޖެހޭ ބަދަލު ކުރުމުގައި ހިސާބުގައި ރާއްޖޭގެ 100 މީޓަރު ދުރުގައި ގޮވާމެއް ފަށާފައިވާކަން ނިކަމެތިކަމުގެ ސަބަބުން ހުރިހާ ކަމަކަށެވެ. ނަގާފައިވާ ގޮވާމުގެ މަޝްރޫއުގައި ބެހެއްޓުމުގެ ބިމުގައި އަތޮޅު ބޭރުގެ ފެންމަތީ ބަދަލު ގިނައިން ބޭނުން ކުރެވޭ ޖެހޭގޮތަށް ތިމާވެށީގެ ބެލެހެއްޓުމުގައި ހިނގާ އާދައިގެ ކުރިއަށް ދިޔަ ހުރިހާ ހަމަޖެހިފައިވެއެވެ. މިގޮތުން ޕްރޮޖެކްޓުގެ ހަމަޖެހިފައިވާ ގޮތުގެ މަޝްވަރާގައި ހިންގާ ތިމާވެށީގެ ކުރިއެރުމަށް ބެލެހެއްޓުމުގެ ފަރާތްތަކާއި ކުރެވިފައިވާ އަސަރުތަކުގެ ބޭނުން ވަނީ ކުރިއަށް ގެންދިޔުމަށް އިތުރު ކަންކަމުގެ ދާއިރާގެ ކުރެވުނު ބައިވެރިވުން ކުރެވިފައެވެ.

އެހެންނަމަވެސް ރިޕޯޓެއް އަންނަމުންދާ ބަދަލުތައްބަލާ މޮނިޓަރިން ޕްރޮގްރާމް މިރިޕޯޓުގައި ހިމަނާފައިވާނެއެވެ. މިފަދަ މޮނިޓަރިން ޕްރޮގްރާމްގެ ބޭނުމަކީ ރިޕޯޓުގައި ކުރާއަސަރުތައް ދުރާލާ ދެނެގަނެ ވިސްނާފައިވާ އަސަރުތަކާ އެކަންކަން ރަނގަޅުކުރުމުގެ ފުރުޞަތު އޮތުމެވެ.

ގދ. ހުވަދޫ، ވާދޫ، ގާއްދޫ އަދި ދަނޑުވެރިކަމުގައި ދަނޑުވެރިކަން ބަލަހައްޓާ ކުރެވޭ ކުރުމުގެ މިމަސައްކަތް ބޭނުމަކީ ގެ ސަރަހައްދު ބަލަހައްޓައިދިނުމާއި ބެހޭގޮތުން ބަލަންޖެހޭ ކަންކަން ފާހަގަކުރެވޭނެއެވެ:

- ބިއްލޫގައި ހައްދާ އިތުރު ބާވަތްތަކުގެ ދަނޑުވެރިކަމުގެ އުފެއްދުންތައް ބަޔާންކޮށް ކުރުމާ މަރުކަޒު ނަތީޖާ ދިރާސާކޮށް ދެނެގަތުން
- ފިނިސަރަހައްދު ބަލަހައްޓާ ހަރު ބޭނުމުގެ ދިގުމުން ބިއްލޫއަށް އުފެއްދުމާ، ބަލަހައްޓަ އާއި ދަނޑުވެރިކަމުގެ ބާވަތްތައް ބިއްލޫގައި އުފައްދާ ދިރޭ ބަލަން ފިޔަވަޅު ފުރުސަތު ހުށަހަޅަން ދެނެގަތުން
- ސިޔާސަތުތަކާއި ނަސީހަތް ގޮތުން ވަޒީފާގެ ފުރުސަތުތަކުގެ އިތުރުވުން
- ހުރިހާ ދިރުމާއި، މާލީ އުފެއްދުމާއި އިޤްތިޞާދީ އަސަރުތަކާއި ގުޅިގެން ، ސަރުކާރު ކުރުން ފަދަ ދާއިރާ ބަލަން ވިޔަފާރިގެ ފުރުސަތުތަކާ ހެދުމަށް ދެނެގަތުން
- އިޖުތިމާއީ މަސައްކަތްތަކާއި ދަނޑުވެރިކަން ކުރާ ކަންކަމުގެ ފަރާތުން އުފެއްދުމަށް ފުރުސަތު
- ގދ. ހުވަދޫ، ވާދޫ، ގާއްދޫ އަދި ދަނޑުވެރިކަމުގެ ހަރަދު ފަދަ ހިސާބުން ގޮތުގައި ބަދަލުއަތުގައި އެކަށައެޅުން ދިރޭ މަސްވެރި އިތުރުވުމާ ދެނެގަތުން
- ފެންގެ އިސްތިޢުމާލުކުރުމާއި، ކެމިކަލްތަކާއި ބޭސްތަކުގެ ބޭނުންކުރާ ދިރާސާކުރުމާ އިތުރުކުރުމުގެ ފުރުސަތުތަކުގެ ދަނޑުވެރިކަމުގެ ބާވަތް އަދި އެ ޤާނޫނީ ބަޔާންކުރުމުގެ ފަރާތުން ދެނެގަތުން
- ސަރުކާރުގެ އެއްބާރުލުން އިތުރުވުމާއި ފެށުމުގެ އުފެއްދުމަށް ދަނޑުވެރިކަމުގެ މިންވަރު ދަށްކުރުމަށް ދެނެގަތުން

ގދ. ހުވަދޫ، ވާދޫ، ގާއްދޫ އަދި ދަނޑުވެރިކަމުގައި ދަނޑުވެރިކަން ބަލަހައްޓާ ކުރެވޭ ސަރަހައްދު ރިޕޯޓުގައި ބަޔާންކުރި ގޮތުގައި ބިނާކޮށްފައި އަދި އިޖުތިމާއީ-އިޤްތިޞާދީ ފަރާތް ފާހަގަކުރެވޭ އިމާރާތް ހިސާބުތަކުގައި ބަލަހައްޓާނެ ގޮތްތައް ހިމެނެއެވެ:

- ބިއްލޫގެ ފަރާތް އަތޮޅު ހިޔާލު މަޝްވަރާ ކުރުމާ ދިރާސާކޮށް ދެނެގަތުން
- ބޯހިލި ފަރާތް މުޅިން ބަލަހައްޓާ ހަމައެކަނި ނަތީޖާ ދެނެގަތުން
- ސަރުކާރުގެ ނުފޫޒު ކައުންސިލުތަކާ ނުފޫޒު އޮފީސްތަކުގެ ޚިދުމަތާ، ފެކްޓްރީ، އަދި މަސައްކަތްތަކާ، ނުކުތާ ބިއްލޫގެ ފަރާތް އިޖުތިމާއީ-އިޤްތިޞާދީ ފަރާތް ބަޔާންކުރެވިގެންދާ ވެއްޓިފައި، ވަޒީފާއަށް ގުޅިގެން އުފެއްދުމުގެ ބަލަހައްޓާ ފުރުސަތުތައް
- ބިއްލޫގެ ދަނޑުވެރިކަމުގެ ޤާނޫނީ ބަޔާންކުރުމުގެ ފަރާތުން ހިމެނޭ ދަނޑުވެރިކަން ބަލަހައްޓަން ކުރިއެރުމަށް ހަރަދުގެ ކަންކަމުގައި ދެނެގަނެ ދަނޑުވެރިކަމުގެ ބިއްލޫގެ ބެހޭ ފަރާތްތަކުން ކުރެވޭ އަދި ބަލަހައްޓާނެ ހަރަދު ބިނާކުރުމުގައި ބޭނުން ކުރެވިދާ ދެނެގަތުން

ނިންމުން:

ބިއްލޫގެ އަސަރު ފާހަގަކުރުމަށް ވަޒީފާގެ ބޮޑު މިރިޕޯޓުގައި ދާއިރާ ކޮންމެ ކަންތައްތަކުގެ މަސައްކަތް ބިނާކޮށް ރިޕޯޓެއް އަސަރުތަކާ މިންވަރު ކުރެވިފައި އަދި ހުރިހާ ކަންތަކުގެ ފާހަގަކޮށް ބިއްލޫގެ ބަޔާންކޮށް ކަންކަމަށް ކުރިއަށް އެދެވޭ

ތަކުލީފުކުރުމުގެ ކުރިން ހުއްދަ ދިނުމަށްފަހު، ކުންފުނިން ހަނދާންކުރަންވާ ތަކެތި ތަކުލީފުކުރުމުގެ ކުރިން ހުއްދަ ދިނުމަށްފަހު ކުންފުނިން ހަނދާންކުރަންވާ ކަންތައް

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2 NON TECHNICAL SUMMARY

1- The report constitutes the Environmental Impact Assessment (EIA) study carried out for Hummingboy Farms (HBF) Pvt.Ltd. for the proposed development of 10 hectares of commercial scale agricultural farmland and the necessary infrastructure in Gdh, Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonireha islands located, southeaster section of South Huvadhu Atoll. The EIA was prepared as fulfilment of the requirement by the Ministry of Fisheries and Agriculture (MoFA) for granting permission for the project. Environmental Impact Assessment (EIA) of development projects is a requirement by the Environmental Protection and Preservation Act (EPPA) (law 4/93) of the Government of the Republic of Maldives.

2- Initial estimate of the project cost is USD 10.2 million and is expected to recoup within six years. Major part of the investment will be on development of seawater cooling system, harbour and access channel, retractable roof envelope, rainwater harvesting system and condensate water collection system, electro chemical sewerage system, solar photo voltaic energy system, infrastructure for staff and service areas, other main infrastructures and equipment. The project will be developed in two main phases. Phase one includes development of an access channel 425x15m and a harbour 50x50m and 3 hectares of advanced hydroponic greenhouses (Approximately 4 hectares of land clearance in GDh. Hulhuvaarulaa), development of power grid, integrated rainwater harvesting system, electro chemical waste water recycling units, installation and operation of deep sea cooling system, Infrastructure construction including power house, oil storage tanks, waste management facility staff accommodation etc.. All key systems will be contained within bunded enclosures, such as the backup generators and fuel storage, and the Solar Power battery centre. In the growing operation best practice in storage and use of all bulk nutrients will be employed. Most of these developments will take place in Hulhuvaarulaa Island.

3- Phase two of the project includes clearance of 6 hectares of land for green house development (2 Hectares from Hulhuvaarulaa and 4 hectares from Menthanduaa and Golhaalaa); construction and operation of accommodation, green houses and other facilities; operation and management of 10 hectares of farm land in four islands.

4- The main produce of the farm will be commercial scale production of tomatoes, strawberry, raspberry and bell pepper.

5- This report has been prepared in accordance with the Environmental Impact Assessment Regulations published by the Ministry of Environment and Energy 2012 and considers a wide range of negative and positive environmental and socio-economic impact arising from the proposed project (development and operations) in the four islands. Major findings of this study was based on information gathered during the field inspection of both the existing environment and possible effects of the project activities, and on-going agricultural projects through extensive literature review and experiences gained from similar projects elsewhere in the Maldives.

6- The proposed project activity will take place on Gdh Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa and the reef. The four islands are uninhabited islands and shares the same house reef with 6 more islands, Maavaarulaa, Kondaanahutta, Farehulhedhoo, Kalhemamal, Maavadhuvaa and the inhabited island of Gadhoo. Four island Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa are vegetated islands (thee islands Hulhuvaarulaa, Menthandhoo, Golhaalaa are sand cays and Dhoonirehaa is a rubble cay) situated on the south eastern rim of Gaafu Dhaalu (Gdh) Atoll. The cluster of four islands are located northern half of Gadhdhoo reef which is a huge reef platform

over 10km long with varying width ranging between 1-1.8km. The total area of the reef platform is over 14.5km^2.

7- Vegetation on the four islands is different due to the nature of the soil content; mainly Menthandhoo, Golhaalaa and Dhoonirehaa are different from Hulhuvaarulaa. Golhaalaa and Dhoonirehaa are vegetated shingle cays (rubble cays) and the eastern part of Menthandhoo is also dominated by rubble. Hulhuvaarulaa formation is completely different form the rest of the islands as the main soil content of the island is calcareous coral sand hence the vegetation succession of the island is more or less similar to the majority of islands in the Maldives. In the three islands that are facing the semi enclosed water bodies, vegetation facing the water body (eastern side of Hulhuvaarulaa, western side of Menthandhoo and Golhaala) have similar vegetation type, where the outer layer consists mainly of, *Pemphis acidula* (kuredhi), *Tournefortia argentea* (boashi) *Pandanus tectoris* (Boakashikeyo) *Scaevola taccada* (Magoo) with occasional *Guettarda speciosa* (Uni), *Hibiscus tilaceus* (Dhiggaa) and *Calophyllum inophyllum* (Funa), Ochrosia Oppositfolia (Dhunburi), Cordia Subcordata (Kaani) *Thespesia Populnea* (Hirundhu), Ficus Benghalensis (Nika). Coconut palm *Cocos nucifera* is scattered in various parts of the three islands Hulhuvaarulaa Menthandhoo and Golhaalaa and abundant mostly in the inner and central parts of the three islands. Few *Barringtonia asiatica* (Kinbi) trees were encountered in Hulhuvaarulaa and two Mangrove trees were found on the western side Menthandhoo. Only few coconut palms are observed in Dhoonirehaa.

8- The total vegetated area of Hulhuvaarulaa is 251,092m^2, Golhaalaa 150,588m^2, Menthandhoo 104,027 m^2 and in Dhoonirehaa 52,336m^2. Vegetation clearance required for land based construction, including pathways etc., is approximately, 73,664m^2 in Hulhuvaarulaa, 21,000m^2 Menthandhoo, 21,000m^2 Golhaalaa, and 13,88m^2 in Dhoonirehaa. This represents approximately 29% of Hulhuvaarulaa, 20% Mendhandhoo, 13% of Golhaalaa and 2% of Dhoonirehaa vegetation cover.

9- Parts of Gadhdhoo Reef encompassing the 4 islands of Hulhuvaarulaa, Golhaallaa, Menthandhoo and Dhoonirehaa can be characterized by distinct bio geomorphic zones. Fore ref zone on the eastern side, backreef rubble zone, backreef seagrass bed on the eastern side, shallow lagoon at the atoll lagoon ward side and seagrass bed in between the islands in the central tidal flat semi enclosed bay area. The reef system reef and lagoon is rich in fish diversity and abundance.

10- In the process of EIA study an impact matrix, which is a standard tool for identifying the possible impacts of project activities, was assembled for the proposed development project in Gdh. Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa. The activities carried out during the construction and post-construction or operational phases are arrayed against a selection of environmental factors that may be affected directly or indirectly as a consequence of project activities.

11- The report has identified and described in detail possible change that would occur to the existing condition of the environment caused during the construction phase and have suggested appropriate mitigation measures for each and every impact identified in the report. The study has identified that most severe negative environmental impact for the islands would be from clearance of 10 hectares of vegetation reef-flat and lagoon excavation for access channel and harbour development and trenching to lay the deepsea cold water intake and outfall pipeline. Liquid, solid and other forms of wastes and particularly hazardous waste generated during the construction and operational phase has also been identified as significant impact associated with the project and appropriate mitigation measures are suggested for each and every waste related impact identified in the study.

12- The study has evaluated alternative options for some components of the project and has suggested some alternative design for harbour recommended to locate harbour basin between the reef flat and

the island approximately 100 off the shoreline and use a piled jetty to connect the harbour basin and the shoreline. However, given the nature of the proposed development and the fact that fairly heavy load will be transported frequently through the infrastructure, practicality of such a harbour needs to be considered and evaluated as an alternative to the proposed harbour in Hulhuvaarulaa. Also the study found, based on similar project activities elsewhere in the Maldives, the island and the reef will recover from the expected impacts rapidly and will re-establish a new ecological balance relatively soon (around 3-5 years). IN order to gather consistent data on possible changes taking place it is proposed to undertake an extensive post-development monitoring programme that will keep on monitoring the environmental changes associated with the development and make necessary adjustment to the activities of the project based on the findings of various measured environmental parameters suggested in the monitoring plan.

13- The study has identified the following beneficial effects form the proposed agricultural development project in Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa:

- Creation of competitive agriculture market for locally grown fruits and vegetables;
- Availability of locally grown high quality salad crops that can cater for the high-end tourist resort
- Employment: Temporary (10-30 job opportunities during construction period) permanent (over 10-20 jobs during operational phase);
- Development of business opportunities in supply and services; and
- Capacity building and technology transfer opportunities in modern farming practices.
- Improvement of public facilities and infrastructure, general improvement of social conditions and service industry activities, in addition to the increased national agriculture and economic infrastructure.
- Better guardianship of the terrestrial and marine resources of the four islands;
- Improvements in environmental quality of the island;
- Stimulation of local economy, cultivation and small business opportunities within the nearby island communities; and
- Increased government revenue and increased GDP.

The study found no evidence that the project requires or involves:

- loss of unique habitat or wilderness areas;
- resettling of local communities;
- removing or destroying cultural properties or archaeological sites;
- contravening national government of the Republic of Maldives, or island community policies, regulations, criteria, customs or aspirations concerning environment, economy, employment, cultural traditions or life styles.

14- On the basis of this environmental impact assessment study and the impact mitigation measures proposed in the report will be duly implemented and recommendations are given due consideration, it is concluded that the benefits of the proposed agriculture development project in Gdh Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa will substantially outweigh an unwelcomed demand of burden on the environment.

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3 INTRODUCTION

3.1 BACKGROUND

Gaafu Dhaalu Hulhuvaarulaa Menthandhoo, Golhaalaa and Dhoonirehaa are four uninhabited islands located on the eastern periphery of South Huvadu Atoll. The four islands are located within the same house reef with Gadhdhoo and been leased by the Ministry of Fisheries and Agriculture to Hummingboy Farms (HBF) Pvt. Ltd. for agriculture related developments leased. HBF is a company created specifically for development and engagement in agribusiness in the Maldives.

The cluster of four islands (Gaafu Dhaalu Hulhuvaarulaa Menthandhoo, Golhaalaa and Dhoonirehaa) are vegetated islands situated on the northern half of, 10km long, 1-1.8km wide, Gadhdhoo reef platform . Approximate land areas of the four islands are; Gdh Hulhuvaarulaa 251,092 m^2 (25.6 ha), Menthandhoo 104,027 m^2 (11.2 ha), Golhaalaa 150,588 m^2 (15.40 ha), and Dhoonirehaa 52,336 m^2 (5.6 ha).

The Hummingboy Farms Pvt. Ltd operations are designed to be completely reliant on solar power for energy needs, rainwater harvesting for water, and cold deep sea water for cooling. By combining these three sustainable elements, it is possible to create optimal growing conditions for many key import crops such as tomatoes, peppers, cucumbers and even strawberries, inside advanced hydroponic greenhouse systems.

In the first phase of the proposed development harbour, access channel, staff accommodation, water tanks, solar panels, warehouse, and 4 hectares of advanced hydroponic greenhouses will be constructed, using fully recirculating nutrient systems, with no pathways for nutrient discharge. All key systems will be contained within bunded enclosures, such as the backup generators and oil storage, and the solar power battery centre. In the growing operation Best Practice storage and use of all bulk nutrients will be employed.

The staff accommodation and utility services are equally sustainably designed. All waste water and sewerage effluent (black and grey) will be treated in situ using an electrochemical process, where no chemicals are used or produced, and no bulk sludge is produced. Domestic water supply is from rainwater harvesting, and energy from the solar arrays. Most of the developments in this phase will take place in Hulhuvaarulaa and Dhoonirehaa.

In Phase Two, 2 similar Greenhouse operations, using identical sustainable systems, will be constructed on the adjacent islands Golhaalaa and Menthandhoo.

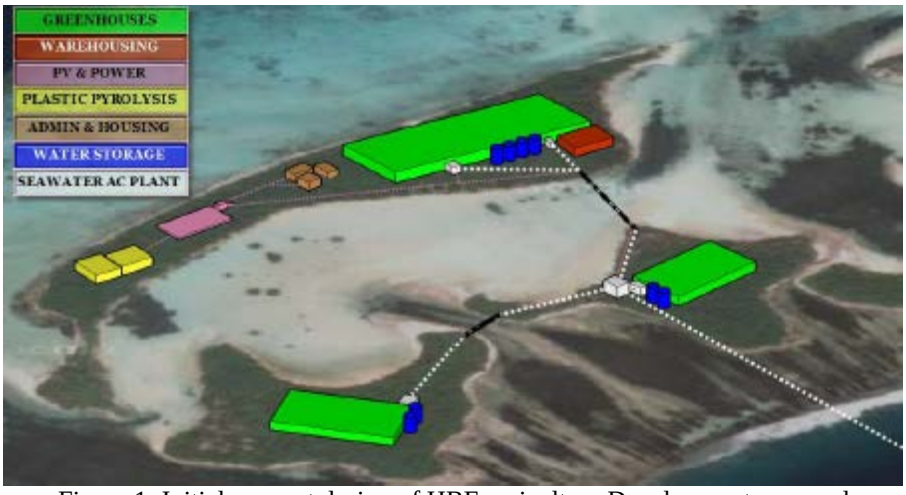


Figure 1: Initial concept design of HBF agriculture Development proposal


Figure 2: Typical of Retractable Roof Envelope system (Greenhouse) by Cravo® that will be used in HBF project (http://www.cravo.com/product_details.html?product_id=10)

Major environmental impact envisaged with the project will be impacts related with vegetation clearance, access channel and harbour dredging and installation of the deep sea Coldwater pipeline.

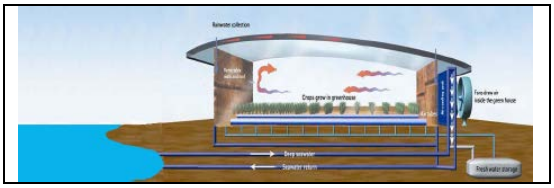


Figure 3: Schematic drawing of the deep sea cooling system and water management

The primary target of the proposed agriculture development project is to produce vegetable and salads crops locally for the growing tourist industry followed by the domestic market. The ultimate objective is to substitute expensive imported products that are, equal to or higher quality than equivalent EU operations, locally grown items. The objective is to offer provision of both skilled and un-skilled employment opportunities for locals and provide an efficient distribution and sales channel for domestic farmers in the atolls whilst increasing domestic food security and climate resiliency.

Overall the proposed agriculture development project will introduce a climate proof and more resilient and sustainable method to grow vegetables and salad crops in the Maldives. The development will contribute to achieve (if replicated in other parts of the Maldives) strategic targets towards achieving food security and overall agricultural development in the Maldives and to create employment opportunities particularly for locals. The project will also generate much needed foreign currency and contribute to the economy through tax revenue and annual rent.

3.2 PURPOSE OF THE EIA

Given the potentially adverse environmental impacts associated with the proposed agricultural development work at Gaafu Dhaalu Hulhuvaarulaa Menthandhoo, Golhaalaa and Dhoonirehaa, the proponent has requested for services of freelance EIA consultants; Dr. Mahmood Riyaz, and Dr. M Shiham Adam to prepare and submit the Environmental Impact Assessment (EIA) report to EPA in compliance with the Environmental Protection and Preservation Act (4/93) and EIA Regulations 2012.

The objective of the EIA study was:

a) To provide an assessment of the potential environmental effects of the proposal and to determine which of these, if any are likely to result in a significant effect on the environment and to propose ways and means of avoiding, mitigating and or compensating the perceived negatives effects of the project;

b) To provide necessary information to EPA applicable to the proposed development; and

c) To assess how the proposals have been developed to achieve a satisfactory level of environmental performance in line with the EIA Regulations

3.3 EIA REPORT AND EIA IMPLEMENTATION PROCESS

In general the objective of an EIA study is to address the environmental concerns of the proposed development project. The EIA will help to achieve efficient planning, aid in identifying impacts and their potential mitigation measures. The EIA report will also help to promote informed environmental and sound decision making during the development of the project.

The aim of the EIA is to identify, describe and assess in an appropriate manner, proposed development, in accordance with the provisions of guidelines and regulations of the GoM, the direct, indirect and residual effects of the project on the following factors:

- Physical and chemical characteristics of the earth (soil and landform,), water (marine and underground), atmosphere (air quality and climate);

- biological conditions including flora (trees/shrubs and endangered species), fauna (coral and endangered marine species) habitats (environmentally sensitive areas protected area etc);

- cultural factors including aesthetic and human interest (scenic views and vistas, wilderness qualities, landscape design, historical and archaeological sites and objects), and cultural status (employment); and

- Ecological relationships including eutrophication, disease and insect vectors etc..

This EIA report has been prepared by the EIA consultants selected by the proponent. Approved ToR of the Environmental Impact Assessment for Agricultural development by Humming Boy Farms Pvt.Ltd. in Hulhuvaarulaa, Menthanddhoo, Golhaalaa and Dhoonirehaa, GDh Atoll is given in Annex 1. A check list of EIA preparation process is given below:

- ✓ The consultant prepares EIA application form with necessary relevant documentations along with a draft TOR for the proponent for submission to EPA, and the proponent submits the application along with necessary documentation from the Ministry of Fisheries and Agriculture (MoFA).
- ✓ EPA calls for a scoping meeting with proponent, consultant and relevant stakeholders from government agencies to determine the scope of the EIA study
- ✓ During the scoping meeting the drafts ToR is finalized by EPA and send to the proponent and consultant
- ✓ The consultant undertakes literature review and gathers relevant data and information on the project.
- ✓ Consultant undertakes the field assessment work and stakeholder consultation
- ✓ The consultant analysis data and information gathered and identify environmental impacts, determine mitigation measures, rationally evaluate and suggest alternatives and limitations and propose a monitoring plan.
- ✓ The consultant discusses major findings with the proponent and suggests possible changes to the project/project component.
- ✓ Based on the discussion with the proponent the consultant reviews the EIA and makes necessary changes to the document.
- ✓ The proponent should provide written commitment to undertake mitigation measures and post-development environmental monitoring as per the EIA report.
- ✓ The consultant submits the final EIA to the proponent who subsequently will submit to EPA for review and to issue decision note.

Once the decision note is issued from EPA the proponent is obligated to implement the EIA and matters highlighted in the decision note. Also the proponent shall implement agreed monitoring programme during construction and operational phase of the project and submit monitoring report as indicated in the EIA report (see Figure 4).

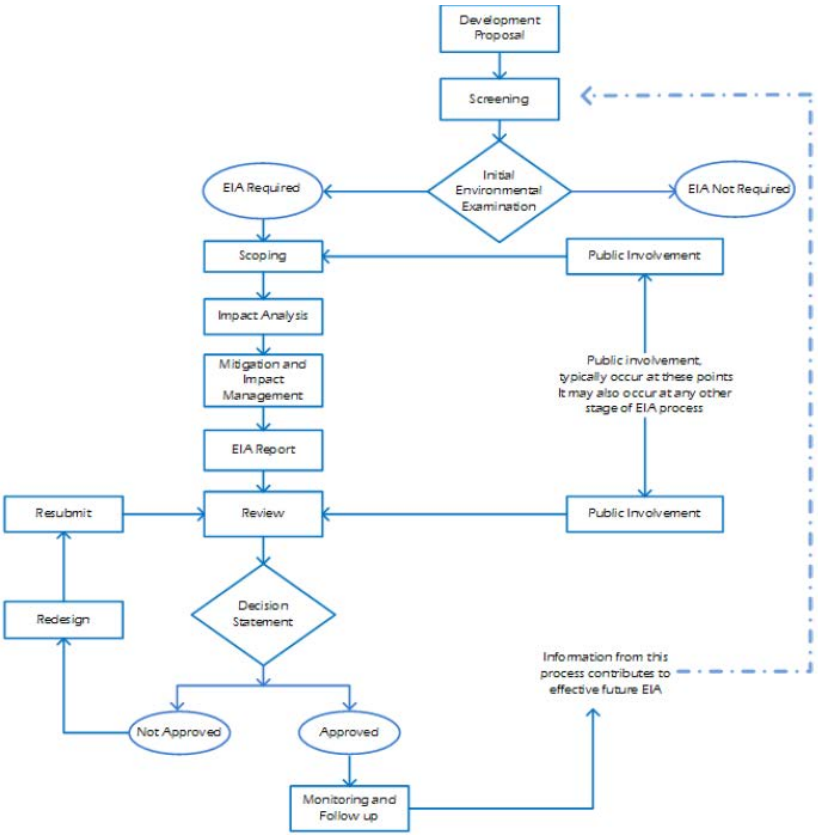


Figure 4: General flow diagram of the EIA process in the Maldives.

3.4 PROJECT SETTING AND STUDY AREA

The cluster of four islands (Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa) lies on a large reef platform situated on the northern half of, 10km long, 1-1.8km wide, Gadhdhoo reef platform . The islands are located on the northern half of Gadhdhoo Falhu in different orientations and shapes (Figures 5 and 6). Hulhuvaarulaa is an N-S oriented elongated island. Golhaalaa has square-shape with an arc-bend on the northern side. Menthandhoo has a stingray shape with its tail pointing southwards. Dhoonirehaa has a horse-bean shape with its bending on the northern side.

There are three islands on the north of this cluster including Maavaarulaa Island located on the northern end, proposed for a domestic airport development. Three islands are on the south of this cluster including inhabited Gadhdhoo Island located on the southern end of the reef platform

Approximate land areas of the four islands are; Gdh Hulhuvaarulaa 251,092 m^2 (25.6 ha), Menthandhoo 104,027 m^2 (11.2 ha), Golhaalaa 150,588 m^2 (15.40 ha), and Dhoonirehaa 52,336 m^2 (5.2 ha).

The length of the reef from northern to southern end is approximately 10 km, reef width is within the range of 1-1.8 km and the total area of the reef where the island cluster is situated is approximately 14.5 km^2.

The main focus of the EIA is to undertake baseline environmental conditions of the project area in the four islands Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa and surrounding environment with regards to identifying the existing status of the environments relevant for the proposed project.

Figure 5 shows location of the cluster of four islands in the Atoll, Figure 6 pan sharpened Digital globe image of the island cluster and the surrounding environment that constitutes the main study area for the proposed project, Figure 10 shows anticipated impact footprint of the proposed development.

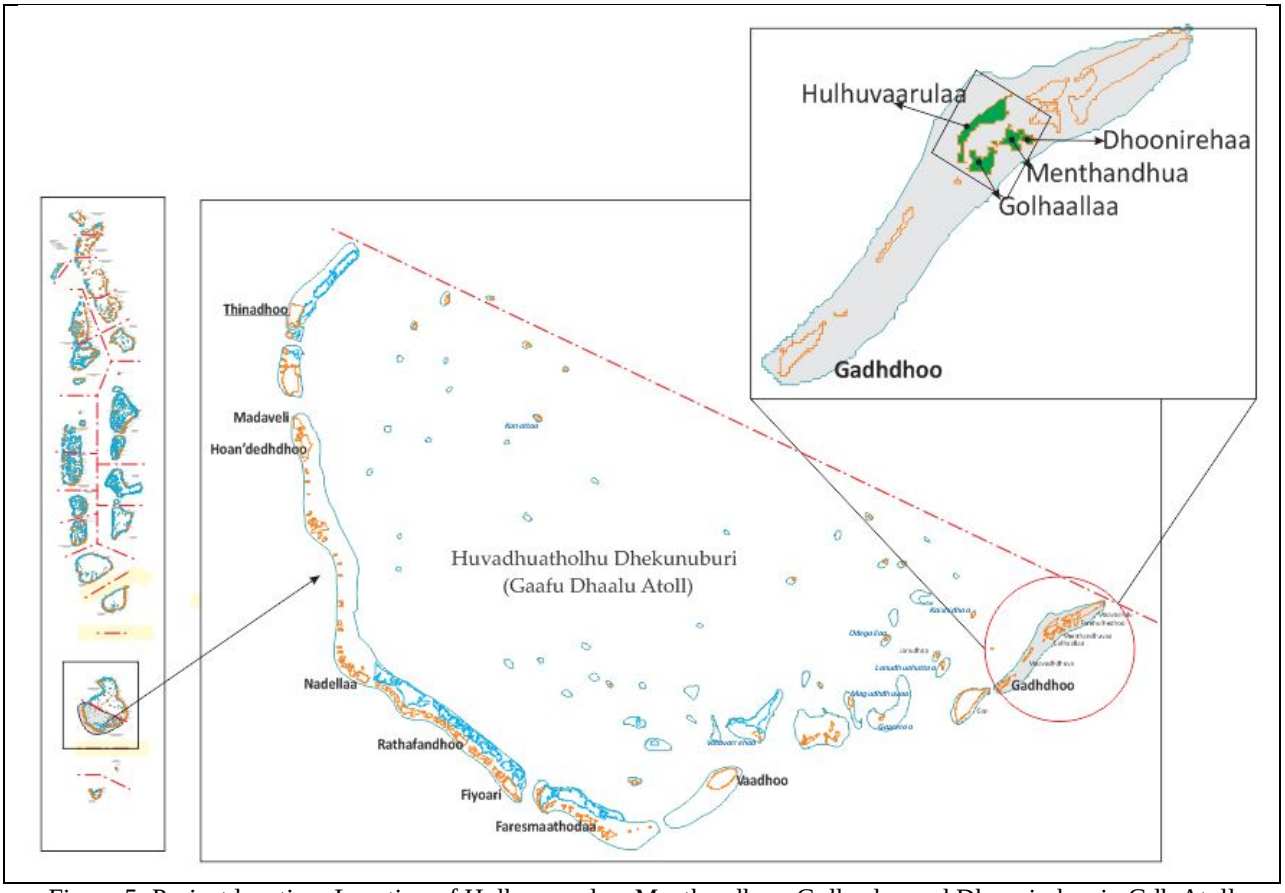


Figure 5: Project location: Location of Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa in Gdh Atoll

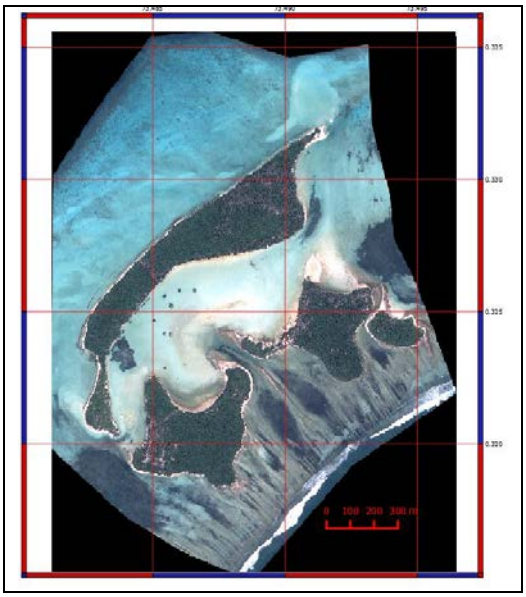


Figure 6: Study area and project boundary, showing the cluster of four islands

3.5 PROJECT RATIONAL AND OBJECTIVE

According to the 2014 census, the imports of fresh agricultural crops that are mainly produced in the Maldives exceeded 9.5 million kg (value over 302 million MVR) in 2014. Imports of fresh agricultural crops mainly produced has been increasing from 2007-2014 annually 16% on average. According to the published statistics from MoFA locally produced agricultural products that are traded in the local market in Male declined 18% from 2009 to 2013, (i.e: 8.1 million kg, value over 144 million MVR in 2009 to 1.4 million kg, value over 34 million MVR in 2013). This clearly indicates that local agricultural production is decreasing while the import of fresh agricultural crops mainly produced in the Maldives is increasing steadily. This indicates the need for agriculture development in order to supress dependency on imports and to achieve self-sustainability and food security.

Agriculture is important to a large sector of the population that are marginalized from the country's commercial fisheries and tourism industries. Nevertheless, agriculture plays a vital role in the livelihood of the rural population. The two-thirds of the population of the Maldives residing in outer islands are involved in fisheries activities and home-garden agriculture.

Although agriculture's contribution to the Maldives' (GDP) is below 5%, its contribution to the economy is underestimated because production is mostly subsistence in nature and usually not measured for purposes of national accounting.

The small size of the population and in most cases the small area of the islands suggest the need to explore different markets and add value to production activities. Agriculture is an important economic activity in almost all of the inhabited islands. Agriculture still retains traditional subsistence characteristics due to the constraints that exist for this activity to expand into fully-fledged commercial activity. This pattern is particularly more protuberant in the field of agriculture where there has been limited intervention in the form of programs that would help the subsector to become commercial.

Limited number of Small and medium scale commercial agriculture has developed over the years, and is most notably present in several larger islands. It is present in both the long term leased agricultural islands, as well as in the larger inhabited islands that have better soil and water resources. The development of agricultural islands is the responsibility of the lessee and the high investment cost on the basic preliminary infrastructure such as harbour jetty etc., which is considered necessary for the transport of agricultural produce to local markets and the import of tools and equipment, is an obstacle to attract large scale commercial agriculture investments.

Commercial agricultural development is a priority in the Sixth National Development Plan (2001-2005) which aims at import substitution of crops that can be grown successfully and competitively in the Maldives, as well as to increase food security of its people. The Government's agriculture policy is to increase production and income through more efficient use of the limited land resources, improve the quality and quantity of production, and promote a balanced development in the rural areas through strengthening agriculture. Improving logistic and institutional capability for agriculture development and investment in tourism has boosted agriculture by providing a reliable market.

The Government has also implemented policy and institutional changes to create more efficient competitive and adaptive private sector involvement in agriculture and related activities to generate employment and income to the rural population. This has been playing a supportive role in food production in the country by diversification of agriculture, enhancement in agricultural production through improvement of market, credit and providing agricultural support services.

The Government encourages and welcomes foreign investment as described on the Ministry of Trade website. There it states that, "…*natural resources and technical know-how in the Maldives are extremely limited. Therefore, in order to provide the economic and social infrastructure of the country, foreign collaboration is needed to utilize the local labour and the available resources along with potential foreign resources to transform the economic strength through capital investment and utilization of technology, expanded knowledge and efficiency, and improved organizational and managerial ability*."

Maldives is a world famous high-end tourist destination where world's rich and famous spend their fortune for a holiday in a resort in the Maldives. Most of the fruits and vegetable needed to cater for the niche market of tourist is imported to ensure reliable quality and consistent supply that meets the needs of resorts. With the expansion of resort to out island in north and south of Maldives, delivery of perishable fruits and vegetable though the existing transports system is time consuming and further degrades the quality of the produce. Therefore, there is a need in the tourism industry for high quality agricultural products at competitive prices that can be delivered on a regular and reliable basis and the tourism resorts offer an opportunity for the marketing of agricultural products. The proposed project is design to tap on the niche tourist resort market to provide locally grown vegetable and salad crops to resorts.

The primary target of the proposed agriculture development project in Gaafu Dhaalu Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa is to produce vegetable and salads crops locally for the growing tourist industry followed by the domestic market. The aim is to substitute expensive imported products with higher quality, equal to or higher than equivalent EU operations, locally grown items. The objective is to offer provision of both skilled and un-skilled employment opportunities for locals and provide an efficient distribution and sales channel for domestic farmers in the atolls whilst increasing domestic food security and climate resiliency.

Overall the proposed agriculture development project will introduce a climate proof and more resilient and sustainable method to grow vegetables and salad crops in the Maldives. The development will contribute to achieve strategic targets towards achieving food security and overall agricultural development in the Maldives and to create employment opportunities particularly for locals. The project will also generate much needed foreign currency and contribute to the economy through tax revenue and annual rent.

3.6 PROJECT SCOPE SUMMARY

The project mainly involves the construction, operation and management of 10 hectares area of agricultural land in GDh. Hulhuvaarulaa, Menthandhua, Golhaalaa and Dhoonirehaa. The proposed project covers the following activities

- Dredging 425m long and 15m wide an access channel;
- Dredging 50x50m harbour to have a minimum depth of -3m at low tide Use the dredged material for harbour backfill island levelling;
- 3 hectares of advanced hydroponic greenhouses in phase One (Approximately 4 hectares of land clearance in GDh. Hulhuvaarulaa);
- Construction of advanced hydroponic greenhouse systems;
- Development of solar power grid for Energy system;
- Rainwater harvesting system;
- Installation of electrochemical waste water recycling units;
- Instalment and operation of deep sea cooling system for Cooling green houses;
- Infrastructure construction including power house, oil storage tanks, waste management facility staff accommodation etc.;

- Clearance of 6 hectares of land for green house development in Phase two (2 Hectares from Hulhuvaarulaa and 4 hectares from Menthandhoo and Golhaalaa);
- Construction and operation of accommodation, green houses and other facilities;
- Operation and management of 10 hectares of farm land in four islands

3.7 REVIEW OF RELAVANT STUDIES

As part of relevant literature review and preparation of the report, the following EIA studies on agriculture development in various parts of the Maldives have been reviewed and used as reference;

EIA for mariculture, hydroponics aquaponics and boatyard development in AA Vihamaafaru by Mohamed Zuhair, November 2015
EIA for the proposed Agricultural Project in Dhaandhoo, Baa Atoll Maldives, by M.S. Adam and & Mahmood Riyaz, March 2013
EIA for the proposed Agriculture Island, Lhohi island Dhaalu Atoll by CDE, July 2012
EIA for Agricultural Development in Noonu Felivaru, by CDE. Pvt. Ltd, December 2012
EIA for Ha Madulu for Agricultural Development, Ihavandhippolhu Atoll, Maldives, by Ecad Associated Pvt. Ltd. July 2008
EIA Ga Funadhoo for Agricultural development, North Huvadhu Atoll, Maldives, Ecad Associated Pvt. Ltd. December 2007
EIA for Agricultural Development, Shaviyani Medhukunburudhoo, by CDE Pvt. Ltd December 2007

Some of these are commercially operational agriculture related projects in the Maldives. Most of the activities that will be undertaken by the proposed project will have similar components and activities, hence could be considered as relevant and appropriate reference material to understand the types, degrees and magnitudes of environmental impacts and potential mitigation measures for the proposed HBF farms in GDh. Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa.

3.8 EIA IMPLEMENTATION METHODOLOGIES

This study was based mainly on data collected during a field investigation mission from 26th to 31st January 2016 by the consultants. Field studies have been undertaken using methods generally employed for EIA studies in the Maldives. The field assessment methodologies are briefly described in Section 6.3 of this report. Environmental impacts were assessed based on the input, process and output. Environmental impacts are predicted by use of widely used descriptive checklists and its significances are evaluated by the use of Leopold matrices. Expert judgment and professional opinion as well as review of relevant EIA studies have also been widely used throughout the impact assessment and evaluation process. These methods are described in detail at the relevant section of this EIA Report.

4 DESCRIPTION OF THE PROJECT

4.1 THE PROPONENT

The proponent of the project is Hummingboy Farms Pvt Ltd, registered in Maldives (Registration number C-0255/2013). Hummingboy Farms Pvt. Ltd is created specifically for the proposed development and future planned expansion. The company will develop and operate agricultural farms in the four islands of Gaafu Dhaalu Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa. International development partners of the project are:

Chief grower- Stephen Clarkson (Sahara Forest Project)
Process Design Phillip Lee (MD, Evolve growing Solutions)
Envelope Design Richard Vollenregt (Md, Cravo Greenhouse)
SWAC & Cooling- Dale Jensen (Makai)
Plastic to oi pyrolysis conversion – Therm Engineering Cp.Ltd (Thailand)
Nutrient Specialists- Wilson Boardman (MD, Micro mix Plant Health)
Marketing and Brand Development- Ray Moule (Abu Dabi Farmers Service Centre)
Seed Suppliers and consultancy – Enza Zaden Beheer B.N (Netherlands)
Energy System- Dr. Paolo Matelloni (Nottingham University)
PV/ Battery – Suntech TBD
Water Supply- Alex Pfeffer (MD, KARUK)

4.2 PROJECT COST

The estimated initial total project cost is USD 10.2 million and is recouped within six years. The NPV15 based on 10 year cash flow is USD 548,436. IRR is 24%. Five year ROI is 117%. Table 1 gives an indicative breakdown of costs for the proposed agriculture development project in Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa islands. Major part of the investment will be on development of seawater cooling system, harbour and access channel, retractable roof envelope development, rainwater harvesting system and condensate water collection system, electro chemical sewerage system, solar photo voltaic energy system, staff and service areas, other main infrastructures and equipment.

Table 1: Investment cost (construction Phase) of Agriculture development project

Development	**Cost in US$ millions**
Harbour and access channel	1.5
Land clearance and earthworks	0.8
Seawater cooling system	2.5
Retractable roof system (greenhouse)	1.5
Sewerage and rainwater harvesting, condensate water collection system	1.5
Solar PV energy system	1.5
Back-up generator sets	0.5
Staff and service area	0.2
Total	**10**

4.3 MAIN DEVELOPMENT FEATURES OF THE PROJECT

The project mainly involves the construction, operation and management of 10 hectares area of agricultural land in GDh. Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa with all the ancillary facilities including island access and harbour, greenhouses, staff accommodation and facilities etc.. Table 2. gives requirements to sustain and operate 10 hectares of farm land in the four islands.

Table 2: Requirements for the proposed development

Requirement	Details
Harbour and access channel	425m long and 15m wide an access channel; 50x50m harbour to have a minimum depth of -3m and Use the dredged material for habour backfill island levelling;
Seawater cooling system	Draw cold sea water from 600m deep (5-10^{o}C) through a 600mm pipe will be installed for cooling the green houses
Advanced hydroponic greenhouses	3 hectares of advanced hydroponic greenhouses in phase I (Approximately 4 hectares of land clearance in GDh. Hulhuvaarulaa); Clearance of 6 hectares of land for green house development in Phase II (2 Hectares from Hulhuvaarulaa and 4 hectares from Menthandhoo and Golhaalaa);
Development of solar power grid for Energy system	PV solar system (720 kW) , including 900m^2 PV panels, their mounts, controller, inverter, solar batteries, AC and DC distributor cabinets etc and a battery house
Fuel storage	Diesel and Petrol storage tanks 3 storage tanks of 50,000 litre each (size 2.3 m diameter x 12 m long) having bunding 0.3 m x 15 m x 15 m)
Water Harvesting from retractable roof envelope	20,000m3 storage capacity, Storage tanks are sized 8 x 60/6 tanks (18.288m x 4.594m) average requirement is 400,000 litres/day
condensate water collection system	Collect and reuse condensate water from the cooling system
Sewerage and waste water	Self-contained electrochemical individual units
Warehouses	2 warehouses (10 x 30 x 3 m),
Accommodation	2 workers accommodation buildings (1 floor building 5.6 x 22 x 2.85 m and 2 storey building 5.6 x 22 x 2.85 5.75 m) , 2 villas (9.1 x 12 x 3 m)
Pumping stations	10 Pumping station

4.3.1 Site Planning and Design

The Hummingboy Farms Pvt. Ltd operations in Hulhuvaarulaa Menthandhoo, Golhaalaa and Dhoonirehaa are designed to be completely reliant on solar power for energy, rainwater harvesting and

condensate water collections for Water, and naturally cold deep sea water for cooling. By combining these three sustainable elements, it is possible to create optimal growing conditions for many key import crops such as tomatoes, peppers, Raspberry and even strawberries, inside advanced greenhouse systems.

In phase I four hectares of advanced hydroponic greenhouses will be constructed, using fully recirculating nutrient systems, with no pathways for nutrient discharge. All key systems will be contained within bunded enclosures, such as the backup generators and oil storage, and the Solar Power battery centre. In the growing operation best practice storage and use of all bulk nutrients will be employed. Most of these developments will take place in Hulhuvaarulaa Island.

The staff accommodation and civil services are equally sustainability designed. All effluent (black and grey water) will be treated in situ using an electrochemical process, where no chemicals are used or produced, and no bulk sludge is produced. Domestic water supply is from rainwater harvesting and collecting condensate waster, and energy from the solar arrays.

In Phase Two, 2 similar Greenhouse operations, using identical sustainable systems, will be constructed on Golhaalaa and Menthandhoo islands. Concept design of the project is shown in Figure 7.

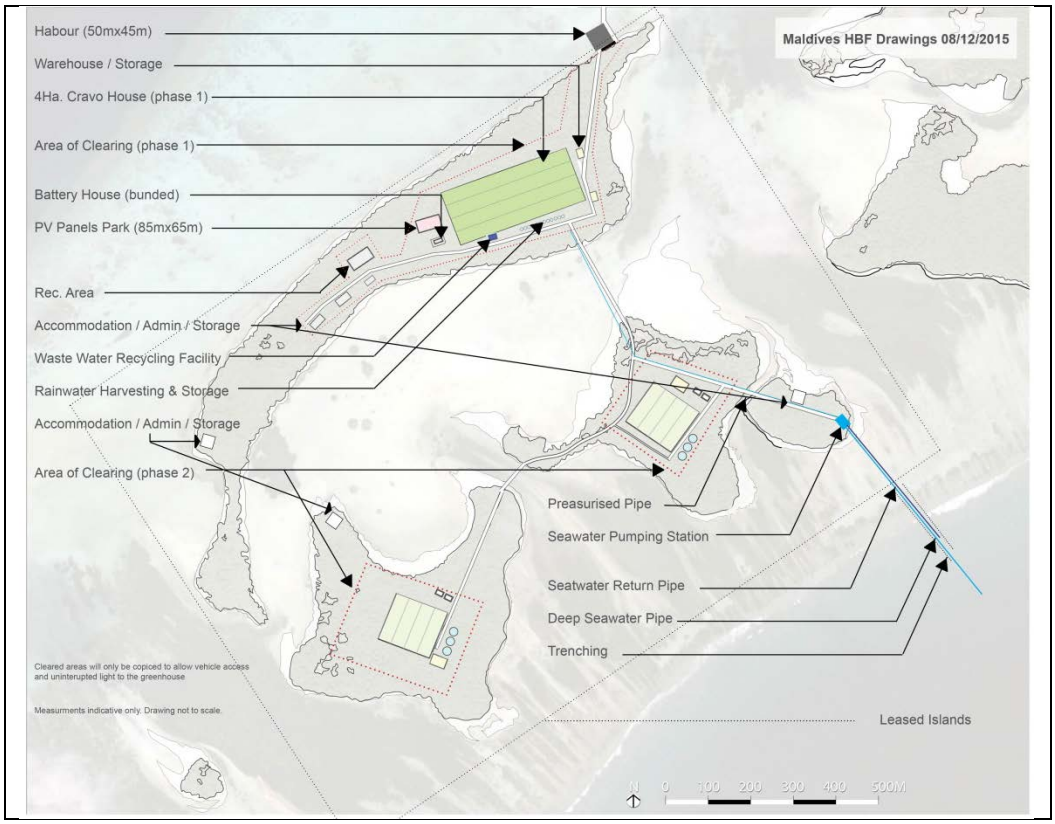


Figure 7: Concept design of the proposed project in Hulhuaaaluraa, Menthandhoo, Golhaalaa and Dhoonirehaa

4.3.2 Harbour and Access channel

To gain access for the island cluster, loading/unloading, for the four islands the company is proposing to excavate a channel and a harbour on GDh. Hulhuvaarulaa Island and use the dredged material for backfilling harbour protection structures and the excess material for island levelling particularly Hulhuvaarulaa. Total length of the channel is 425m and the width is 15m and the harbour is 50x50m. The

channel and the harbor will be dredged to have a minimum depth of -3m at low tide. Estimated volume of material that will result from channel dredging is approximately 19,125 cbm and from harbour 7500 cbm making the total volume of dredged material 26,625 m^3. Dredged material will be used as backfill for harbour protection structure and the excess for levelling Hulhuvaarulaa Island.

Location of the channel and harbour is selected based on the shortest path. The following figures give details of the proposed channel and harbour dredging.

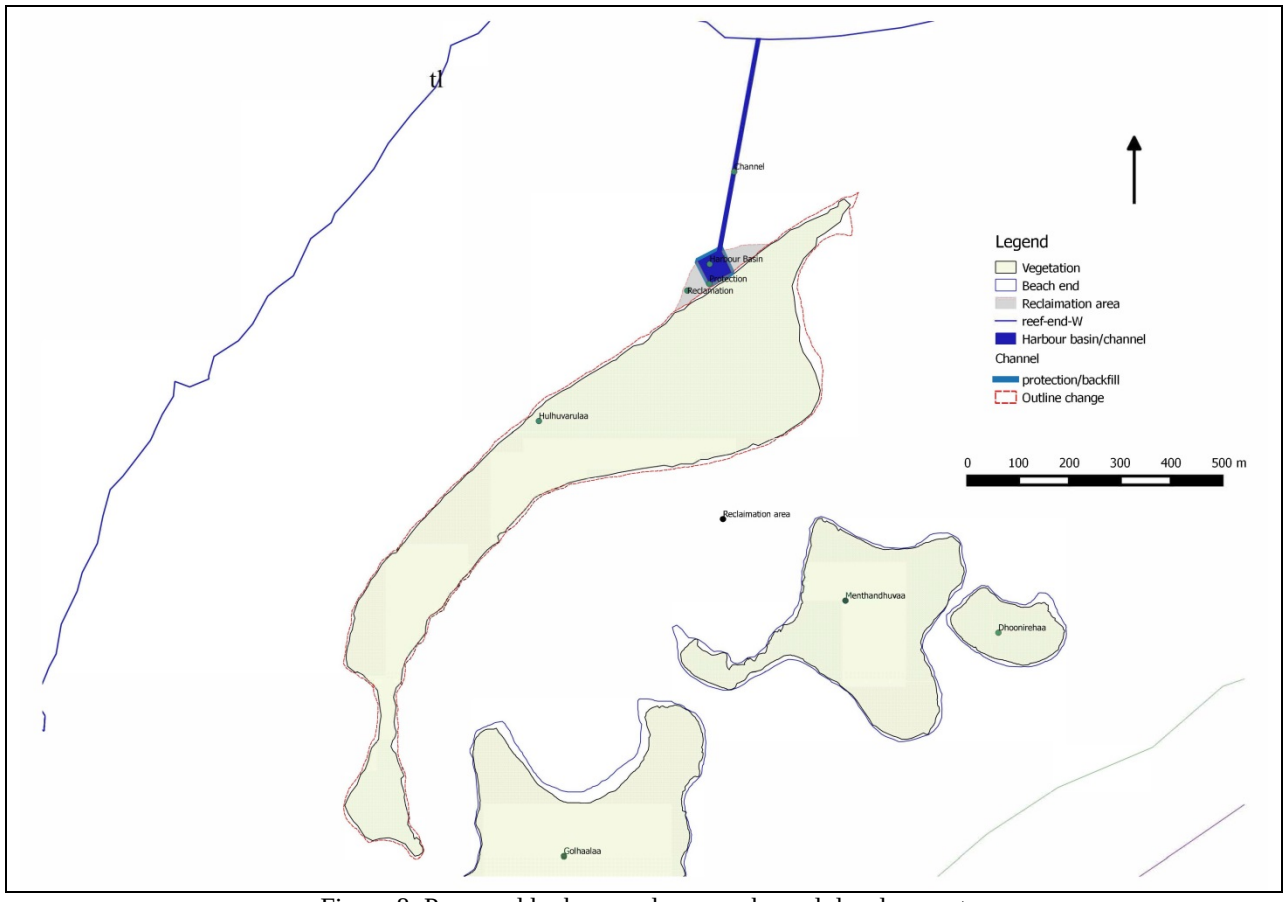


Figure 8: Proposed harbour and access channel development

4.3.3 Land clearance

The total vegetated area of Hulhuvaarulaa is 25,092m2, Golhaalaa 150,588m^2, Menthandhoo 104027 m^2 and in Dhoonirehaa 52336m^2. Vegetation clearance required for land based construction, including pathways etc., is approximately in Hulhuvaarulaa, 73664m^2, Menthandhoo 21,000m^2, Golhaalaa 21,000m^2 and Dhoonirehaa 1388m^2. This represents approximately 29% of Hulhuvaarulaa, 20% Menthandhoo, 13% of Golhaalaa and 2% of Dhoonirehaa. Details of key structures and components of the project are described in this section and land use plan is shown in Figure 2 and concept design is shown in Figure 6. Breakdown of space allocation for land based structures is given in Table 3.

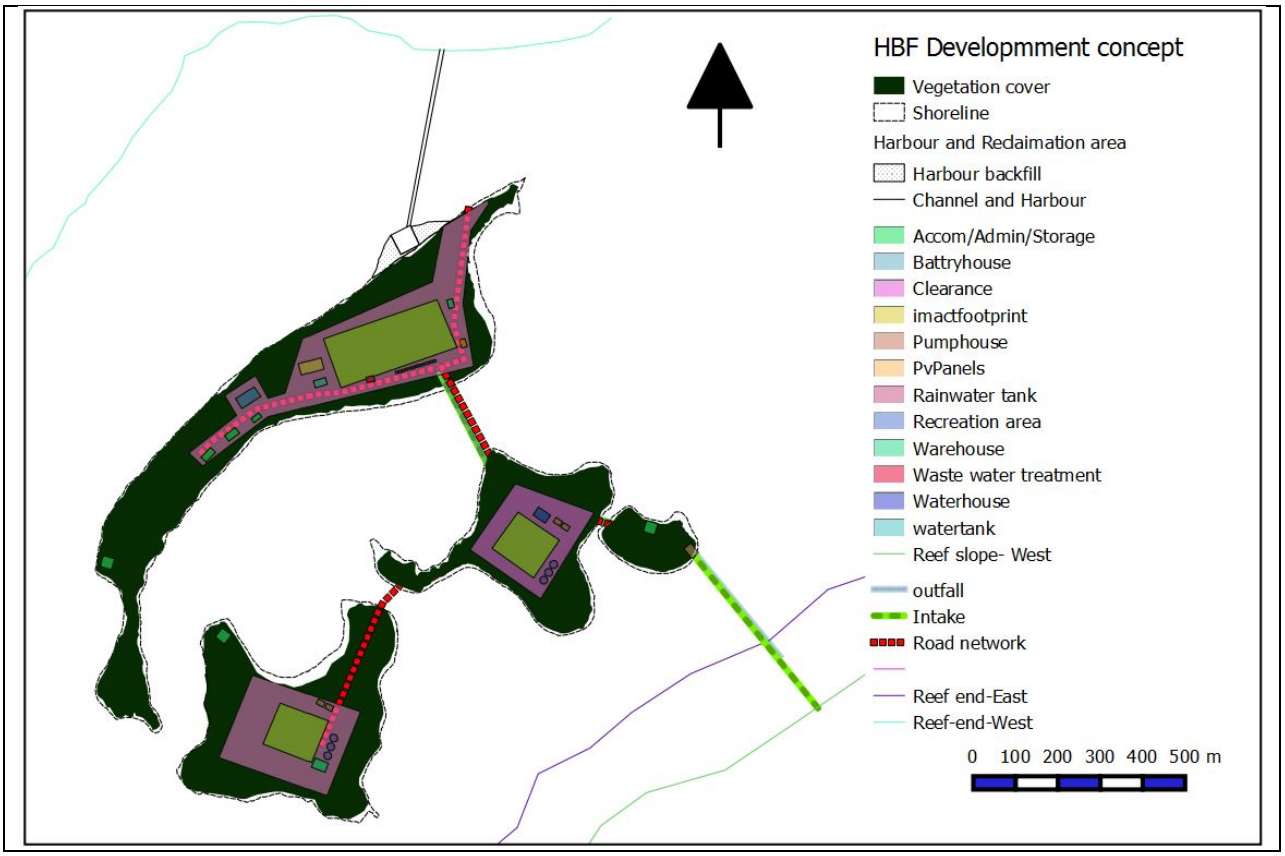


Figure 9: HBF Project landuse plan

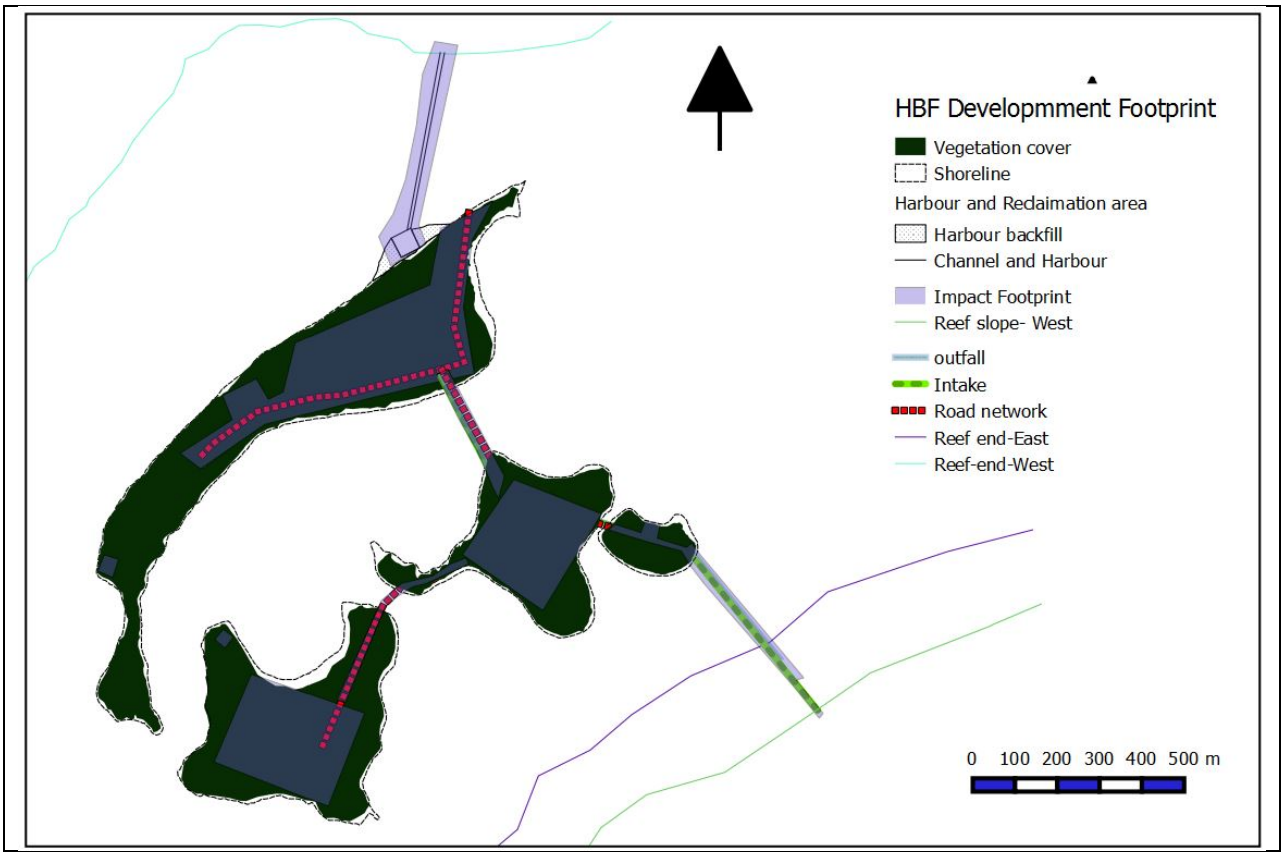


Figure 10: Impact footprint of the project affected area

NO #	Type	Area m^2	% Total land area (4 islands)	% vegetation cleared area
1	Cleared land	109073	19.5%	0
2	Greenhouse	51236.8	9.2%	47.0%
3	Rainwater tank	800	0.1%	0.7%
4	Pv Panels	1483.08	0.3%	1.4%
5	Battery house	503	0.1%	0.5%
6	Accommodation/admin/storage	3620	0.6%	3.3%
7	support buildings	1631.87	0.3%	1.5%
8	Warehouse	2154.96	0.4%	2.0%
9	Recreation area	1480.3	0.3%	1.4%
10	Pump house	1554.5	0.3%	0.6%
11	Waste water treatment	262.52	0.0%	0.2%
12	Trench line	7963.1	1.4%	7.3%
	Total built-up area	**72690.26**	**13.2%**	**66.6%**
	Total land area 4 islands	**558043**		
	Impact foot print	**117052**		

4.3.4 Types of crops that will be grown (details production fertilizers, optimum time etc)

The following Table 3 displays targeted varieties and expected growth timescales for each product line. It is anticipated that production will be at a yield and quality level equal to or higher than equivalent EU operations.

Species	Variety	Days		
		Propagation (30cm/5leafs)	To first harvest	Crop lifespan
Tomatoes	Salad-loose	35	84	365
	Salad-Vine	35	106	365
	Cherry/plum-loose	35	75	365
	Cherry/plum-vine	35	98	365
	Beef	35	98	365
Strawberry	European	25	14-21	120
Raspberry	European	25	12-18	120
Pepper	Bell Pepper- Green	35	98	200
	Bell Pepper- Yellow	35	119	200
	Bell Pepper- Orange	35	119	200
	Bell Pepper- Red	35	119	200

4.3.5 SeaWater cooling system

The sea water cooling system in this project has the core function to harness cooling using deep sea water and deliver cold air within the greenhouse for the benefit of the plants. Water is channelled through a heat exchanged that transfer the cooling to an inner closed loop that comprises all the small heat exchanger that will cool down the air delivered to each individual row of plants. A simple schematic of the system is shown in the Figure 9.

Typical steps for environmental consideration:

1. A land station to hold the marine pumps, of 3m below sea level depth, is to be constructed. This is to ensure the pumps are always below sea level.

2. A shallow trench will be dug across the reef to protect the pipes from wave action. Once the pipes are in place, gravel and boulders/concrete blocks will be used to cap the backfilled trench. Pipe cool water intake discharge pipe installation process is shown in Figure 12 .

3. The flow and return pipes are 600-800mm wide.

4. The depth of the returning (warmer/more nutrient rich) sea water discharged pipe is calculated to ensure it is of a significant margin of ecosystem safety below the depth where any thermal pollution/algae bloom could occur. This is currently being calculated, but will at 50m depth. Furthermore, the water flow at different temperature will return at a rate that will have any thermal impact to the surroundings.

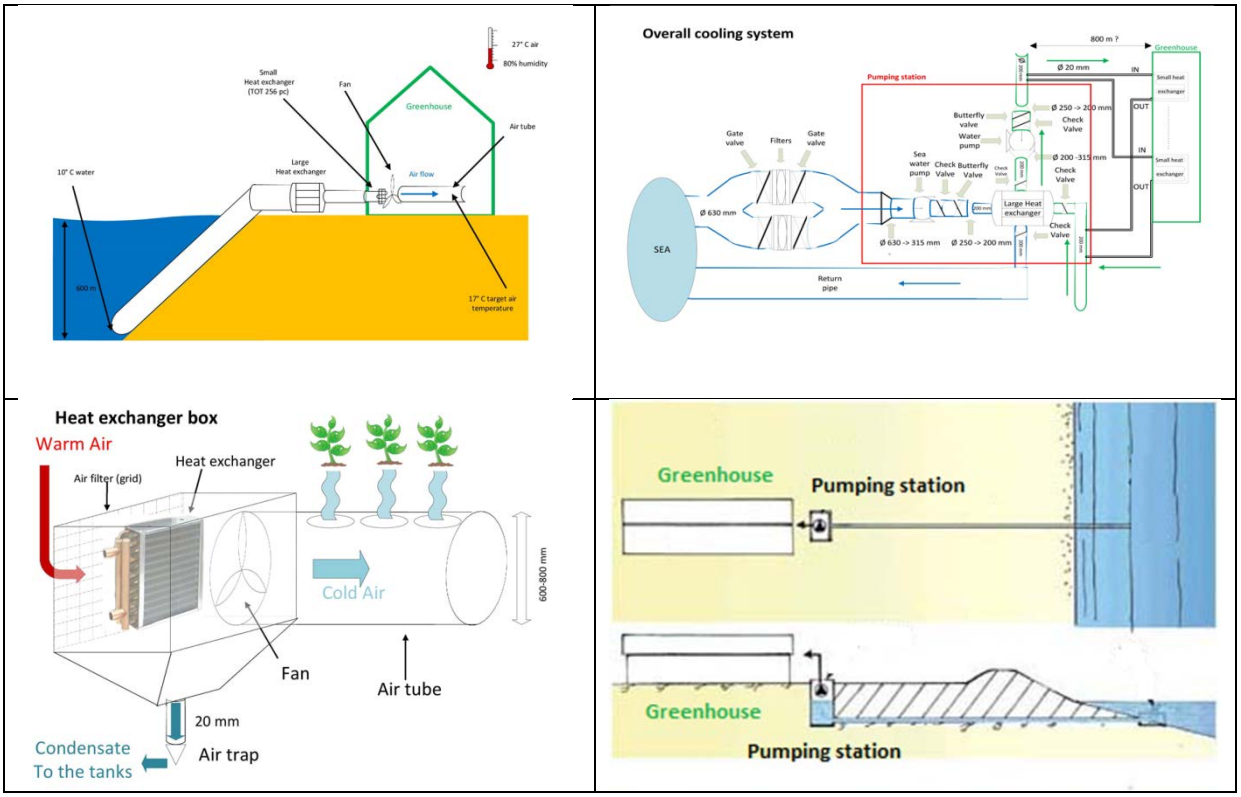


Figure 11: Seawater cooling system design details: TOP LEFT; overall schematic of the sea water cooling system (SWAC), TOP RIGHT; Detailed representation of the SWAC with pipes network (pumping station with its components to be contained within is marked in red), BOTTOM LEFT; details of the heat exchanger block, BOTTOM RIGHT; Configuration of the pumping station building

The seawater cooling system is a critical part of the sustainable profile of the project. One of the foremost international marine engineering companies, and the world's leading specialists in Sea Water cooling systems, Makai Ocean Engineering, based in Hawaii, have been engaged to fully design and oversee the instillation of the HBF cooling system. With over 20 similar projects successfully commissioned worldwide, their expertise is assured. The small scale of the HBF system makes this the least impact system they have ever designed.

Ten pumping station will be constructed below water level to solve engineering problems of water pressure. This will require to excavate an area deep enough to host the "concrete box" that will act as grounded building. A simplified representation is offered in Figure 12.

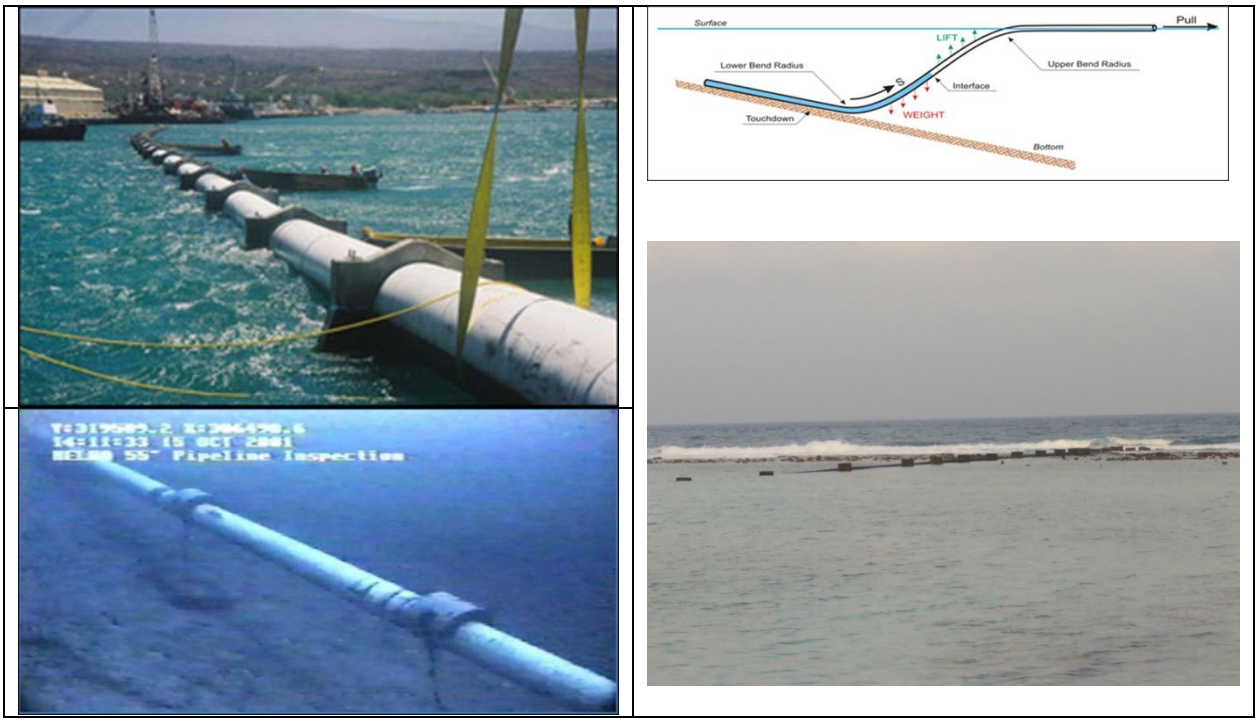


Figure 12: Cold seawater intake pipe lying procedure: TOP LEFT; Sea water pipes assembly in shallow lagoon, TOP RIGHT; pipes laying procedure in the trench, BOTTOM LEFT; pipes correctly installed at sea bottom. BOTTOM RIGHT; similar but shallower installation in Hulhumale eastern side (sewerage pipe)

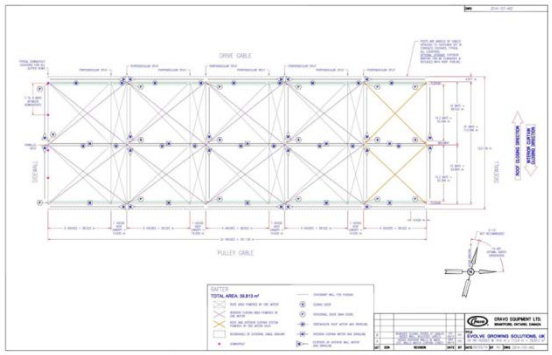
4.3.6 Greenhouse

In the first phase 3 hectares of advanced hydroponic greenhouses will be constructed in Hulhuvaarulaa, using fully recirculating nutrient systems, with no pathways for nutrient discharge. The greenhouse is designed to achieve maximize the natural conditions available from the Maldives climate. Details of the components of the greenhouse system are given below:

Retractable Roof Envelope

The retractable roof system is manufactured by Cravo® . This system enables the plants to benefit from "outside" growing conditions when required whilst also enabling rainwater harvesting. They are able to withstand sustained wind speeds in excess of 150 km/h. Available standard dimensions and specifications of retractable roof envelopes are given below and a typical design and set-up is given in Figure 11

- Standard house widths: 7.31m, 9.14m, 9.6m, 10.97m, 12.8m
- Gutter heights: 3.65m, 4.3m, 4.87m, 5.5m
- Roof closing time: 2.5 minutes
- Maximum area powered by 1 motor: 4,400 m2
- Maximum wind load: 225km/h



Details drawing of the greenhouse structure

Hanging gutters where the plants will be hosted

Greenhouse completely set up

Typical ground inside the greenhouse

Figure 13: Typical retractable greenhouse design and setup

Internal shade curtains

Integrating an internal shade curtain shades plants from mid-morning sunlight when the radiative load begins to have a negative effect, through to mid-afternoon when the radiative loads have reduced. Due to the envelope design, natural ventilation occurs utilising a 2m high airflow column pathway between ridge and screen, every 4 metres Figure 14.

Figure 14: Internal shade curtains

Hanging Gutters

Hanging gutters will have the following advantages:

a. Increase light re-reflection back into the lower levels of the crops – increasing yields by 5-8%
b. Reduce transmission of diseases by isolating the plants from the ground
c. Increase harvesting efficiency
d. Enabling cool air to be distributed below as well as above the crop
e. Enabling maximum crop protection in the event of a low level storm

4.3.7 Cooling system

Cold seawater pumped from approximately 600m deep will pass through heat exchangers enabling uniform distribution at 10-12 Celsius below the original temperature of the green house envelope. The greenhouses will be equipped with air tubes to evenly distribute cool air to the crop. Air tubes will be used in tandem with hanging gutters, they do not impose on the crop area, and can be easily accessed for maintenance and replacement over time. The air tubes are fed by fans linked to heat exchangers in the plenum areas alongside the greenhouse structure (Figure 15).

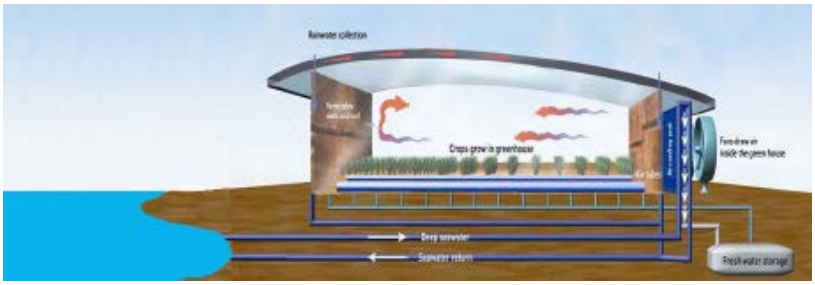


Figure 15: Greenhouse cooling system and air tubes

4.3.8 Water production

Island groundwater aquifer will not be used for any purpose at any stage of development and operational phase of the project. All the water needed for the island during construction and operational phase of the project will be provided through establishment of an integrated water management system, which includes rainwater harvesting and collection of condensate water from the cooling system.

Rain water storage capacity of 20,000m^3 will be developed in the island. Initial estimate for water requirement is approximately 400,000l/day (400m^3/day). To meet this demand 8 rainwater storage steel tanks will be developed each tank will be 60 x 6 feet, 18.288 x 4.594 m (Figure 14).

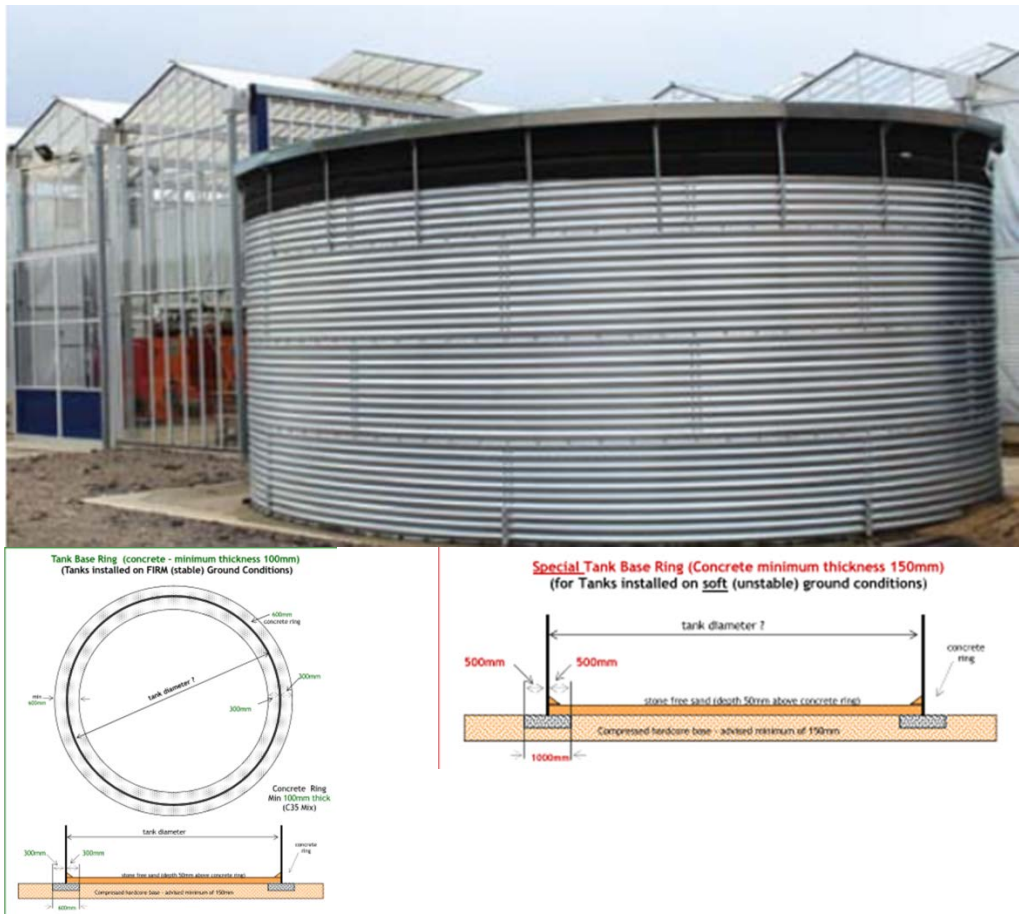


Figure 16: Water tank and detail drawing of the tanks foundation

Production of condensate water is a very new state-of-the-art technology but it has already been used in hot and humid environments. The humidification and de-humidification that result from differences in temperature between surfaces heated by the sun and cold water from the sea are the keys to the seawater greenhouse system. Seawater is pumped into pipes in the greenhouse and is trickled down over the first evaporator, a large spongy honeycomb-like surface. As air is drawn through the honeycomb and into the greenhouse by fans, it is cooled by the seawater and becomes more humid. The cool humid air creates favourable growing conditions for the greenhouse crops. At the back of the greenhouse, the cool air is drawn through a second evaporator containing seawater that has been heated by the sun in the ceiling pipes. The air then becomes hot and humid to the saturation point. When the hot humid air meets an array of vertical pipes containing cold seawater, fresh water condenses (just like hot steamy air in your shower condenses on the cooler mirror and tile surfaces). The fresh pure water is then piped to a storage container and used to irrigate the crops. A total four tanks to collect condensate water will be built in Hulhuvaarulaa. Figure 15 is a Schematic of the condensate recovery system from the greenhouses. Studies by (Lovichit et.al 2007) have indicated that 26-9% of the irrigated water to the plants can be collected and recovered through this system. The system is now used in the Middle East, Oman and Dubai.

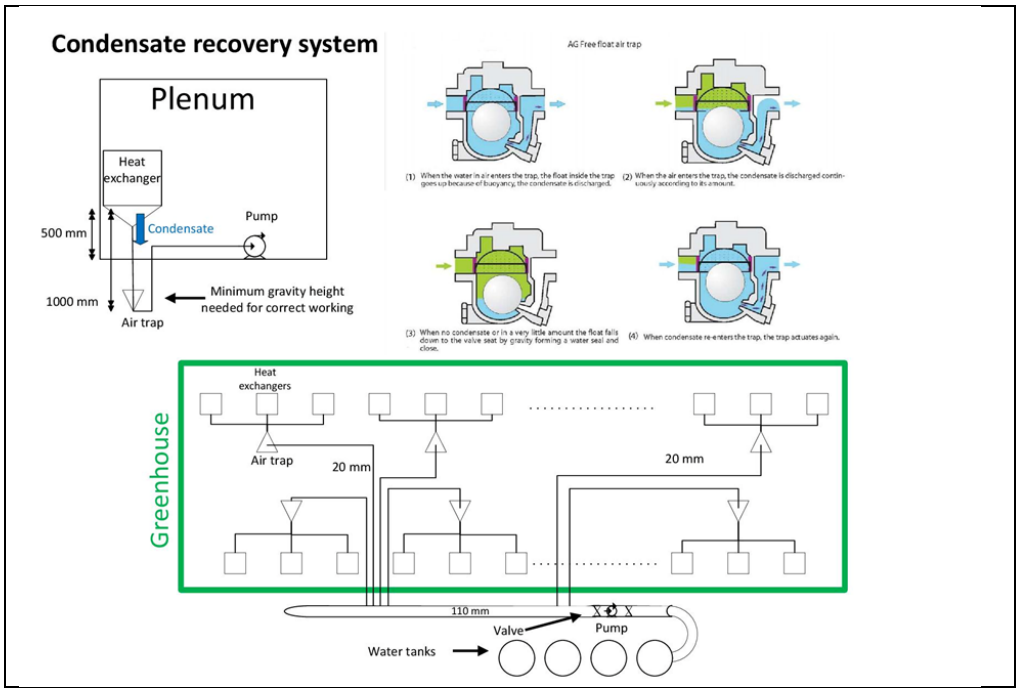


Figure 17: Schematic of condensate recovery system that will be established in the HBF

Water needed during the construction phase will be from the temporary rainwater harvesting and storage system from the roofs of temporary buildings. During the operational phase an integrated water management system will be used in the islands.

The irrigation system is designed to contain Nitrogen, Phosphorous and Potassium (NPK), in closed loop, stored in secured, bunded areas. All other micronutrients are of organic nature, and used in minute quantities (PPM), offering no vector or pathway for polluting the local environment

4.3.9 Waste water and sewerage system

Unlike the convention sewerage and waste water management systems used in inhabited island and tourist resorts in the Maldives, the proposed system for the Hammingboy Farms will not have outfall for sewerage. Each accommodation block will have standalone sewage treatment. It is an electrochemical process with no output other than clean water.

The waste water recycling unit will handle the sewage stream (both Black and grey water). The system is an electrochemical system where power is the only raw material and requires no chemicals or other consumables. Most importantly such system does not produce any bulk sludge after treatment. It consists of a containerized unit to save on additional cost of travel, erection commissioning and also civil works at site. Sewage Treatment system is designed to eliminate the persistent pollutants from sewage using synergistic combination of electrocoagulation, electro-chemical oxidation and electroflotation processes. The waste water treatment system has been combined with 3 electrochemical reactors (electrolytic cells), using electrolysis process including

- Electrocoagulation cell
- Electrooxidation cell
- Electroflotation cell

The system is simple Plug and play type system. A basic schematic is shown in Figure 16. The supplier will be in charge of supervising the installation, commissioning and staff training.

Figure 18: Basic components of the sewage and waste water treatment unit

Civil works will be required for the plinths of the "containerized" unit, electrical work will be required to connect the electrical devices within the unit to the electricity grid and relevant plumbing work will be needed to connect to and from the unit to the black and grey water pipes. Such cleaning system will be strategically designed to service the nearest group of buildings. There will be three self-contained and independent units one of each island to save on pipe works, pumps and optimize the size of each systems to the specific nucleus usage (commercial, rather than residential, rather than occasional)

4.3.10 Power

Approximately 70% of the power for the operational needs of the facility will be generated from installation of photovoltaic solar power generation system that will be installed in 1483m^3 area in Hulhuvaarulaa. The remaining 30% will be generated by using diesel generator.

The PV solar system which will be either mounted on rooftops or in the ground will generate approximately (720 kW). The system will include PV panels, their mounts, controller, inverter, solar batteries, AC and DC distributor cabinets etc. The installation will be supervised by the supplier that will instruct locally contracted electricians.

A list of electrical component is reported in the schematic below (Figure 17). The AC grid will be 380V excluding the accommodation where normal appliances, working with 220V, will be installed.

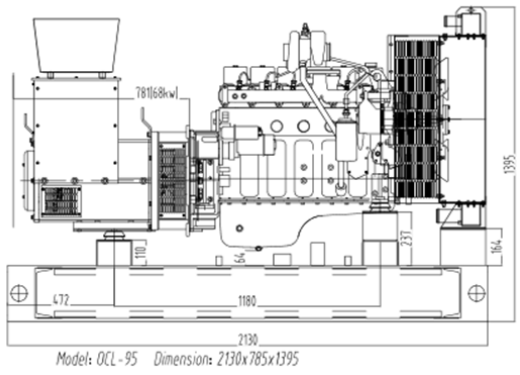
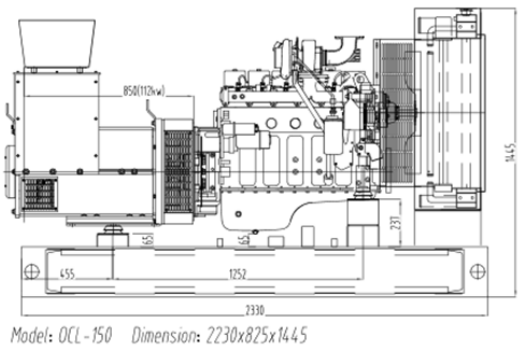
Figure 19: Schematics of the PV solar energy system and energy grid and details of foundations design for PV panels stands

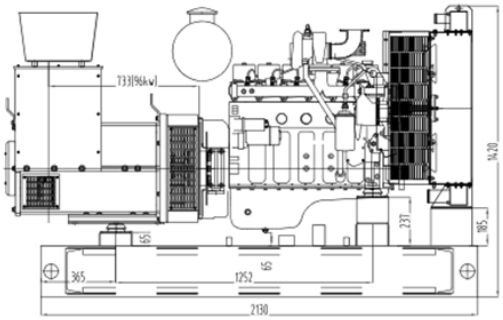
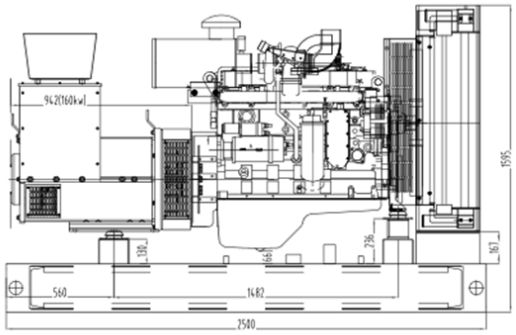
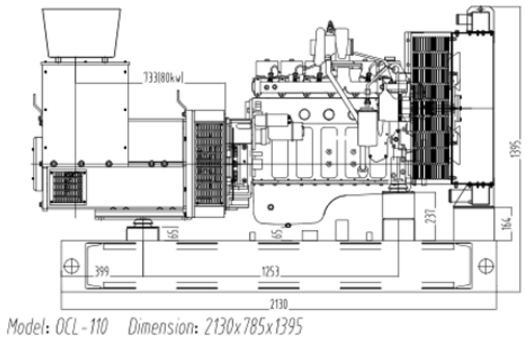
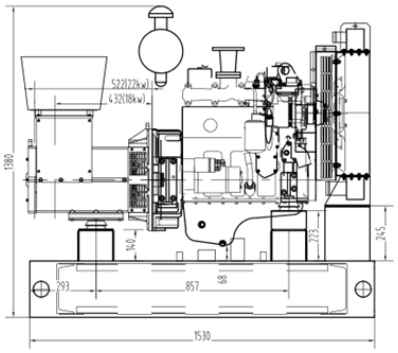
4.3.11 Energy backup system

The energy backup system is constituted by a series of diesel generator with their diesel storage tanks. They will be installed in the proximity of the distribution cabinet before the local load. Details of the gensets are given below and detailed specifications are given in Table 3 :

- 1 generators to match load of 68 kW at 380 V (irrigation)
- 1 genset to match load of 112 kW (cooling system pump 1)
- 1 genset to match load of 96 kW (cooling system pump 2)
- genset to match load of 160 kW (256 fans, it is calculated based on 0.5 kW each fan but as an alternatively could have 2 gensets of 80kW or 4 gensets of 32 kW so it can be easier in the case of wanting to use only half of the fans)
- 2 genset of 20 kW (accommodation and warehouse)

Table 3: Specification of Gensets for backup

1 Generator set to match load of 68 kW @ 380 V (irrigation)		1 Genset to match load of 112 kW (cooling system pump 1)
		
Genset Model	OCL-95	OCL-150
Cummins Engine Model	6BT5.9-G2	6BTAA5.9-G2
Standby Power(kVA)	95	150
Standby Power (kW)	76	120
Prime Power (kVA)	85	140
Prime Power (kW)	68	112
Alternator Model	LTG224F1	LTG274FA1

Fuel consumption	~15l/h	~ 30l/h
1 Genset to match load of 96 kW (cooling system pump 2		1 Genset to match load of 160 kW (256 fans @, 0.5 kW each fan)
 Model: OCL-130 Dimension: 2130x785x1420		 Model: OCL-225 Dimension: 2500x935x1595
Genset Model	OCL-130	OCL-225
Cummins Engine Model	6BTA5.9-G2	6CTAA8.3-G2
Standby Power(kVA)	130	225
Standby Power (kW)	104	180
Prime Power (kVA)	120	200
Prime Power (kW)	96	160
Alternator Model	LTG274E1	LTG274J1
Fuel consumption	~24l/h	~19l/h
Alternative 2 gensets of 80kW or 4 Gensets of 32kW		2 Gensets of 20 kW at 220 V (Accomodation)
 Model: OCL-110 Dimension: 2130x785x1395		 Model: OCL-25, OCL-30 Dimension: 1530x700x1380
Genset Model	OCL-110	OCL-25
Cummins Engine Model	6BT5.9-G2	4B3.9-G2
Standby Power(kVA)	110	25
Standby Power (kW)	88	20
Prime Power (kVA)	100	23
Prime Power (kW)	80	18
Alternator Model	LTG274C1	LTG184EA1
Fuel consumption	~ 19l/h	~5.51 l/h

Requirement of generator sets is set based on the need to save energy and fuel and reduce the wastage by operating large gensets to generate small amount of energy.

All the generators will be placed in the powerhouse and the powerhouse will be centrally located in Hulhuvarulaa the operational area in a single storey building. The power supply from the generators fed through a synch panel for feeding uninterrupted power supply. The powerhouse will be manned 24/7 and logs are kept at hourly intervals. The power house will be equipped with safety equipment and staff is given ear-plugs. The noise levels measured outside the building about 15-10 m at ground level is about 65-75 db form the source. Noise insulation baffles are constructed to minimize the impact of noise emission from the generator sets.

Fuel will be transported to Hulhuvaarulaa by registered or approved fuel suppliers. A fuelling system will be installed at the jetty head through fuel transportation vessels and fed into the storage tanks through secured underground pipelines. A 50,000 liter capacity diesel fuel storage tank, 230cm in diameter and 12m in length, made of 7mm steel with demountable tank will be used for storage. The bund around the take will have be 0.3x15mx15m this is more than 110% capacity of the storage tanks to ensure to contain accidental spills and leakages. All building will have an offset of 7m from the oil storage bund as per the Fire and Safety Regulation.

4.4 MAJOR CIVIL WORKS

4.4.1 Initial Mobilisation and Site Preparation

Site mobilisation and construction equipment, materials and workforce to the island can be brought in after EIA approval and completion of the temporary jetty construction. Workforce facilitating construction of temporary jetty, access and other preliminary facilities will be first accommodated in Gdh Gadhdhoo Island until completion of the construction camp. Construction work will commence after establishment of the necessary facilities such as access and jetty.

Construction work requires use of heavy machinery and special equipment. Some of these include excavators, lorries, trucks, loaders and the like. A practical solution would be to bring these equipment after clearing the access channel and creating a small landing area, a sand bed extended to the deep access channel, where a flat top barges, landing crafts or roll-on-roll-offs with the machinery can reach close to the beach. An approach that is commonly used is to create a sand bed from the beach to the deck of the barge. The heavy machinery can then simply drive over the bed on to the island.

4.4.2 Entrance Clearance and Harbour Development

To gain access for the island cluster, loading/unloading, for the four islands the company is proposing to excavate a channel and a harbour on GDh. Hulhuvaarulaa Island and use the dredged material for backfilling harbour protection structures and the excess material for island levelling particularly Hulhuvaarulaa. Total length of the channel is 425m and the width is 15m and the harbour is 50x50m. The channel and the harbour will be dredged to have a minimum depth of -3m at low tide.

4.4.3 Excavation, Foundations and Construction Systems

For construction of greenhouses and accommodations conventional building methods that do not require deep foundation structures will be used. Such shallow foundation based structures does not require any dewatering and removal of soil will have negligible impact on the environment. Therefore all buildings

would consist of masonry work, reinforced concrete and structural steel work using manual labours and a mini excavator. In water structure such as foundation of the jetty and walkway between the islands would be constructed using Spun concrete ICP piles which will be driven to sea bed using crane mounted piling rig. Although some damage and alteration is expected during this process this is expected to be insignificant and temporary.

All the concrete beams and pad-columns that will be used for construction of the walkway between the islands will be pre-casted on land and brought to the site by using excavator and crane. To lay the foundation pad of the column, the seabed will be excavated 1-1.5m and the precast pad-column foundation will be placed inside the excavated area by using a mini-crane or an excavator and buried.
Column density in the walkway area is approximately 1 column/2m^2 and. Column density will have impact on the water and sediment flow through the columns.

For the building such as warehouse, accommodation buildings, powerhouse and battery house etc., beam foundations are most common and probably most cost effective foundation type being adopted in the Maldives. Since low rise buildings do not require withstanding heavy loads. Beam foundations however, require excavations along the beams with larger footings at the columns. This would mean some excavations and piling up of sand around the building footprint. For single storey buildings, the practice in the Maldives has been to excavate about 0.3 – 1.2 m for foundation. They are sufficient and are known to last for 20-30 years.

Power cables, sewer, drainage and water pipe grids will be connected through underground trenches. Mini excavators will be used for trenching work.

4.4.4 Workforce and Services

Relatively small construction workforce will be maintained on the island during the construction period. In this regard, around 20-30 construction staff will be stationed in Gadhdhoo island and on site.

4.4.5 Site Office and Temporary Accommodation

A site office and temporary accommodation blocks will be constructed at the initial phase in Hulhuvaarulaa and watch posts will established in Menthandhoo, Golhaalaa and Dhoonirehaa. In locating temporary accommodation as well as material storage and other construction-related infrastructure and services in the four islands special attention would be given to ensure the all the vegetation clearance will be maintained within the already established clearance boundaries.

4.4.6 Utilities

At the early stages of construction work portable water for drinking will be brought from Gadhdhoo Island. Since the workforce will be stationed in rented houses in Gadhdhoo island , electricity from a gen set will be used for construction equipment operations. 1500-2000 litre rain water tanks will be kept on site for rainwater collection from the roofs of temporary accommodation blocks. Electricity need for the island during the construction period will be generated through an 85-kVA Generator set which will be installed at the commencement of initial mobilization.

4.4.7 Services Health and Safety

Construction workers will be provided with daily meals and necessary entertainments facilities. The contractor will ensure that the construction activities are carried out under the supervision of a suitably experienced person and reasonable precautions and safety measures are implemented at the site

throughout the construction period. Warning signs barricades or warning devices will provided for all the worker and will be obligated to wear them at the construction site at all times.

4.4.8 Construction Waste Management and Disposal

General domestic waste generated from material consumption by construction workforce and the construction will be managed according to the waste regulations. The proponent will ensure that all construction related waste during demobilizations along with other wastes is properly transported using a licenced vessel from EPA and disposed-off as per the waste regulations and EPA guidelines.

4.4.9 Pollution Control Measures

The following pollution control measures will be strictly implemented during the construction stage:

- All the machinery and equipment will be properly tuned and maintained to reduce emission leakage and spill;
- Proper fuel paints, lubricants, and other chemicals handling and transport measures will be strictly implemented and the fuel storage will be bunded;
- To handle any accidental liquid spills, spill kits will be maintained in the construction site; and
- standalone sewage treatment units through electrochemical process with no output other than clean water will be used for sewage and wastewater disposal at the commencement of initial stages of construction period.

4.4.10 Fire Prevention

Water based fire extinguishing will be preferred during the construction period. Pumps connected to the sea will be installed prior to commencement of major construction activities and other fire extinguishing equipment would also be readily available and employees will be trained to use it in case of fire breakout in the construction area. Potential fire prone activities such as welding and cutting will be carried out by experienced personnel and proper precautionary measures will be strictly followed in the construction site

4.4.11 Fire Detection and Protection System

Fire detection systems will consists of smoke / heat detectors, manual calls points and Fire alarms with repeater panel. Warehouse, accommodation buildings with will be fitted with manual call points and smoke detectors in common areas. All plant rooms will be fitted with detectors.

Fire protection system will consist of ring main distribution with one diesel, one electric fire pump and one jokey pump with hose reels and hose cabinets as per local regulation.

4.5 PROJECT ACTIVITIES – OPERATIONAL PHASE

Key activities identified throughout the operation of the proposed project would cultivation in greenhouses, processing, seawater cooling system and brine reject disposal, waste water and sewerage system, water production, pest control and power generation and management. These activities will have environmental impacts; therefore, there will be regular environmental monitoring to understand the environmental impacts of the proposed project during the operational phase

4.5.1 Cultivation

In Hummingboy Farms all the crops will be grown in a controlled and enclosed environment in advanced hydroponic greenhouses using fully recirculating nutrient systems, with no pathways for nutrient discharge. In the first phase 3 hectares of greenhouse will be developed in Hulhuvaarulaa and in phase

two similar greenhouse operations will be constructed in Golhaalaa and Menthandhoo. The proposed development will be a state of the art environmentally sustainable development where latest technology in the field will be employed.

4.5.2 Transport

Sea transport will be the mode of transport to and from the island. Necessary supplies to the island will be transported from Male'. As the main target of the project is to cater for the resort markets all sea transport facilities will use the harbour to access the island. Main access for the island will be through Hulhuvaarulaa, then by land transport system that will be developed in the island. Transport on the island pick-up trucks and other small vehicles. Relevant road infrastructure will be developed between the four islands.

The harbour operation will involve the berthing/anchoring and mooring of incoming vessels. The vessels will in turn have solid waste management concerns including dumping of solid waste such as plastics and non-biodegradable waste into the harbour area. Therefore, it will be necessary to have a regular harbour cleaning programme and making provisions for awareness and signs and appropriate facilities for discouraging littering.

Harbours and the long access channel will cause significant impact on the alongshore transport regime of the island, thereby causing erosion in the less of the harbour in which case maintenance of these areas would be a core activity. The alongshore sediment movement will also cause infilling of the harbour basin and the access channel which needs occasional maintenance dredging to maintain the depth accessible for the vessels. The proposed monitoring programme will help to identify the overall changes to the dynamic shoreline.

4.5.3 Deep seawater cooling system

After the installation of the deep seawater cooling system that will be used for cooling the greenhouses will have negligible impact on the environment. The impact of the system will only be limited to warmer/more nutrient rich seawater discharge pipe, operation of pumps and impact on the alongshore sediment movement from installation of the pipe particularly in shallow water. Warmer/ nutrient rich water from the cooling process will be disposed into the open sea out of the reef flat through the discharge pipe. Since the area proposed for discharge outfall is located at the open ocean (ocean ward side) with strong wave and current action resultant strong mixing and will ensure that ecosystem safety below the depth where any thermal pollution/algae bloom could occur.

4.5.4 Waste Management

The island will have a Solid Waste Management Plan. All green and organic wastes will be recycled to create fertilizers. Other combustible and non-combustible matter will be taken to a waste disposal site designated by the Government authorities on a regular basis.

4.5.5 Sewage and Wastewater Disposal

Since the maximum number of staff permanently working in the project will not exceed 20 and hence the quantity of waste water and sewage would be very low therefore the proposed wastewater and sewage is a standalone sewage treatment .Each accommodation block will have standalone sewage treatment. It is a electrochemical process with no output other than clean water.

The waste water recycling unit will handle the sewage stream (both Black and gray water). The system is an electrochemical system where power is the only raw material and requires no chemicals or other consumables. Most importantly such system does not produce any bulk sludge after treatment.

4.5.6 Power Generation, Fuel Management, and Waste Oil Disposal

The project will be powered by use of mix energy source Photovoltaic solar power and diesel generators as backups. Approximately 70% of the power for the operational needs of the facility will be generated from installation of photovoltaic solar power generation system that will be installed in 1483m^3 area in Hulhuvaarulaa. The remaining 30% will be generated by using diesel generator.

The PV solar system which will be either mounted on rooftops or in the ground will generate approximately (720 kW). The system will include PV panels, their mounts, controller, inverter, solar batteries, AC and DC distributor cabinets etc. The energy backup system is constituted by a series of diesel generator with their diesel storage tanks. A 50,000 liter capacity diesel fuel storage tank, 230cm in diameter and 12m in length, made of 7mm steel with demountable tank will be used for storage. The bund around the take will have be 0.3x15mx15m this is more than 110% capacity of the storage tanks to ensure to contain accidental spills and leakages.

4.6 INPUTS AND OUTPUTS

Table 4: Matrix of major inputs to the project construction and operational phase

Input resource(s)	Source/Type	How to Obtain Resources
Construction Phase		
10-30 construction Workers	Foreign/ local	Contractor's employees, 1 engineer and a 3 site supervisor Recruited through bidding and announcement in local papers, and recruiting agencies etc.
Construction material	Reinforcement steel bars, river sand, cement, aggregates Timber; retractable roof system by Cravo®, 600-800mm steel pipe, electrical cables and wires, DBs, MMCBs and MCBs, PVC pipes, light weight concrete blocks, light weight, telephone cable CAT, PVC conduits, core armored cables, PP-R pipe, Pump, floor and wall tiles, gypsum boards, calcium silicate boards, zinc coated corrugated metal roof, paint, varnish, lacquer, thinner, dry walls etc.	Imported and locally purchased where available
Heavy machinery (excavators lorries, dumpers, concrete machine and operational tools)	Contractor's machinery	Hire locally/ contractors machinery
Maintenance tool and equipment	Maintenance parts and fluids required for the machinery	Import or purchase locally where available
Fuel and lubricant for machinery	Diesel, Petrol, Lubricants	Local suppliers/contractor
Fresh water	Rain water collection	Drinking water purchased from nearby inhabited islands

Electricity/ energy during construction	Diesel generator	1 Genset 96 kVA diesel generator
Electrical appliances/machinery	Energy efficient machinery and appliances	Local suppliers if available if not import
Fire fighting equipment	Fire pumps, Fire protection system, and Foam fire extinguishers.	Local suppliers if available if not import
Operational Phase		
10-15 operational staff	Mostly locals and few expatriate	Recruited through bidding and announcement in local papers, and recruiting agencies etc. priority will be given to locals from nearby islands
Water supply	Integrated rain water management system	Rain water collection form the roofs of green houses and accommodation buildings
Drinking water	Bottled water	Locally purchased empty bottles will be sent back to the company for recycling
Cooling system for greenhouses	Deep sea cooling system	Sea water obtained from 1000m deep
Electricity/energy	Mix solar 70% and 30% Diesel	Photo Voltaic Solar and Diesel generator
Maintenance material	Timber, electrical cables, electrical appliances, paint, thinner etc.	Locally purchased
Telecommunications	PABX system, fax machines, email and internet facilities to all guest facilities, communication hut at BoH area	Local telecom companies
Transport	by sea	Launches and Dhoni
Food	Locally produced sources. Preference will be given to locally grown agricultural items and produced food items.	Import and purchase locally (fruits, fish and vegetables).
Laundry chemical	Detergent, all-purpose cleaners, glass cleaners, bathroom cleaners, destainer, softener, alkali neutralizer, detergent, detergent plus, stain spots remover, etc. preference will be given to bio-degradable compounds	Imported and locally purchased
Paper products	tissue roll, tissue boxes, hand tissues, office use paper products	Local supply if available if not import. Recycle products and fabric material tissues will be preferred
Fire fighting equipment	Fire Pumps, Fire Protection System, Smoke Detectors, Carbon Dioxide and Foam Fire	Local suppliers

	Extinguishers, etc.	
Fuel, Kerosene and LPG	Light Diesel, LPG Gas, Petrol, Lubricants	Local suppliers

Table 5: Matrix of major outputs construction and operational phase

Outputs (s)	Anticipated quantities	Disposal method
Construction phase		
Green waste from site clearance	Large quantities	mulched on site and used composting, charcoal production
Construction Waste	Small quantities	combustibles burnt/ incinerated others sent to Thilafushi
Fuel and lubricant for machinery	Minor quantities	Gathered in a barrel and sent to Thilafushi
Waste water from workers	Minor quantities	Managed through the stand alone sewage treatment units
Operational Phase		
Non portable water	100-200 liters/day	Managed through the stand alone sewage treatment units
Portable water	10-20 plastic bottles/ day	Plastic Bottles – crushed and sent to the bottling company
Sewage and wastewater	20-50 liters/person/day grey water laundry waste water	Managed through the stand alone sewage treatment units
General Domestic waste	Over 50 kg/day	Managed through waste management system
Kitchen and organic waste	Over 10kg/day	Managed through waste management system
Waste oil and grease	Over 10 liters/ month	Nearest waste management center/ Thilafushi
Scrap metal/cans/plastics	10-20 kg/month	sent to Thilafushi
Paper and Plastics, packaging waste	5-10 kg/month	sent to Thilafushi
Glass and glass bottles	50-100 bottles/month	sent to Thilafushi
Hazardous waste	Minor quantities	Properly sealed in containers and sent to Thilafushi

4.7 DEVELOPMENT SCHEDULES

The Table 6 shows the project activities to be carried out from EIA preparation to start of HBF operations in the four islands.

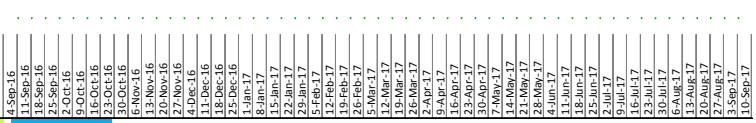
Table 6: Tentative project development schedule

Table

Project - AGRICULTURE DEVELOPMENT IN GA. HUDHUVAARULAA, MENTHANDUAA GOLHAALAA AND DHOONIREHAA, GAAF DHAALU ATOLL

Today's Date: 08/08/16
Start Date: 08/31/16

Ser.	Tasks	Start	End	Duration days
1	EIA preperation and approval	08/31/16	10/30/16	60
2	Deep water cooling sytem preliminary survey	09/18/16	10/18/16	30
3	Deep water cooling sytem detailed survey	10/18/16	12/02/16	45
4	site Mobilization	11/01/16	12/01/16	30
5	Vegetation Clearance	12/01/16	01/15/17	45
6	Preliminaries	09/15/16	10/10/16	25
7	Access channel and harbour	10/06/16	01/04/17	90
8	Earthwork and foundation	11/06/16	02/04/17	90
9	Installation of deepwater cooling pipe and pumps	12/06/16	03/06/17	90
10	Greenhouse constuction	02/06/17	03/08/17	30
11	Installation of Utilities	11/12/16	01/16/17	65
12	Construction of main buildings	03/21/17	05/05/17	45
13	Interior and finishing work	04/20/17	05/10/17	20
14	Demobilsation of constuction equipment	04/09/17	04/29/17	20
15	Start of operations	05/01/17		



5 REGULATORY CONSIDERATIONS

5.1 INTRODUCTION

The proposed agriculture development project in a cluster of four islands Gdh Atoll Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa Islands will be subject to the laws in particular Environmental Protection and Preservation Act (No. 4/93) of Maldives. Thus, it must satisfy the EIA process and get approval before the project starts implementation. This section outlines and summarizes key policies, applicable laws and regulations and regulatory bodies regarding environmental protection in the Maldives.

5.2 POLICY GUIDANCE

The environmental management and policy direction is taken from a number of policy documents prepared by the Government of Maldives. Key documents outlined in this EIA are currently being implemented towards sustainable development of the country. They key policy direction is taken from most recent policy documents that were available at the time of the EIA preparation.

5.3 NATIONAL FRAMEWORK FOR DEVELOPMENT (2009 – 2013)

One of the most important environmental policy guidance is given in the Strategic Action Plan (SAP) of the National Development Framework for 2009-2013. Due to the fragile nature of the country's environment, all the development activities must ensure that appropriate care is taken to protect the environment. Environmental sustainability is the basis for socio-economic development, hence, the SAP outlines the key environmental policies that will be implemented in the country for environmental protection and sustainability, while one of the key environmental goals of the country is to protect and preserve the natural environment to ensure prosperous economic development. The environmental policies outlined in the SAP include;

Policy 1: Strengthen EIA process with an emphasis on EIA monitoring
Policy 2: Conserve and sustainably use biological diversity and ensure maximum ecosystem benefits
Policy 3: Develop resilient communities addressing impacts of climate change, disaster mitigation and coastal protection
Policy 4: Strengthen adaptation and mitigation responses for beach erosion and develop a system to assist communities where livelihood and property are affected by beach erosion
Policy 5: Ensure management of solid waste to prevent impact on human health and environment through approaches that are economically viable and locally appropriate
Policy 6: Ensure protection of people and the environment from hazardous waste and chemicals
Policy 7: Improve air quality to safeguard human health
Policy 8: Enable a fully functional decentralized environmental governance system
Policy 9: Develop a low carbon economy to achieve Carbon Neutrality by 2019
Policy 10: Inculcate environmental values in the society and enable environmentally friendly lifestyle

The Ministry of Environment and Energy and Environmental Protection Agency takes the lead role in implementing the above national policies through various strategies and regulatory measures.

5.4 THIRD NATIONAL ENVIRONMENT ACTION PLAN (2009 – 2013)

NEAP 3 sets out the agenda for environmental protection and management in the Maldives for the five year period 2009 – 2013. This plan is targeted to achieve measurable environmental results that matter to the people of the Maldives.

The aim of developing NEAP 3 is to protect and preserve country's environment and properly manage natural resources for sustainable development of the country and encompasses ten principles, six strategic results with targeted goals to be achieved under each result.

The key principles of the NEAP 3 are;

Principle 1: Environmental protection is the responsibility of every individual
Principle 2: Achieve results
Principle 3: Promote and practice sustainable development
Principle 4: Ensure local democracy
Principle 5: Inter-sectoral co-ordination and co-operation
Principle 6: Informed decision making
Principle 7: Precaution first
Principle 8: Continuous learning and improvement
Principle 9: Right to information and participation
Principle 10: Environmental protection complements development

The six strategic results of NEAP3 are: resilient islands; rich ecosystems; healthy communities; safe water; environmental stewardship; and a carbon neutral nation with 30 result oriented environmental goals that will be achieved in the span of the NEAP 3.

5.5 MALDIVES NATIONAL STRATEGY FOR SUSTAINABLE DEVELOPMENT (2009)

The Maldives National Strategy for Sustainable Development (NSSD) outlines the key objectives, principles and goals that the country will embark toward achieving sustainable development. Hence, the overall direction of the NSSD is to build a nation which appreciates the true value of the natural environment, utilizes its natural resources in a sustainable manner for national development, conserves its limited natural resources, has built the capacity to learn about its natural environment and leaves a healthy natural environment for future generations.

The guiding principles outlined in the NSSD are;

Principle 1: Promotion and protection of fundamental human rights
Principle 2: Equity within and between generations
Principle 3: Democratic and open society
Principle 4: Full participation of businesses and civil society

Principle 5: Policy coherence and coordination
Principle 6: Use best available knowledge
Principle 7: Precaution first
Principle 8: Make polluters pay

While the country will be steered in accordance with the underlying principles of NSSD, the country aims to achieve very important environmental goals, including; adapting to climate change, protecting coral reefs, achieving carbon-neutrality in energy, ensuring food security, establishing a carbon neutral transport system, protecting public health and achieving full employment and ensuring social security.

5.6 MALDIVES ECONOMIC DIVERSIFICATION STRATEGY, 2013

The national strategy outlines sectoral development targets and goals by the year 2025. In this regard, agriculture and fisheries sector development targets are;

Increase agricultural production to reach US$150 million by 2025. This will be achieved through implementation of the following strategies;

- Scale up the production of organic vegetables and tropical fruits
- Expand the access to existing tourist markets
- Build the reputation of local crops as reliable and as of high quality
- Invest in support infrastructure
- Provide training, demonstrations and support for farmers
- Enhance access to finance, and
- Increase the land area allocated for agriculture

5.7 NATIONAL SOLID WASTE MANAGEMENT POLICY, 2007

National Solid Waste Management for the Republic of Maldives was developed in 2007 as an important step towards mainstreaming waste management in the country. The key strategic principles outlined in the document include; establishing polluter pay principles, integrated solid waste management, best practice environmental option (BPEO), best available technology not entailing excessive costs (BATNEEC), proximity principle and private sector participation. It is an important priority of the Government of Maldives as identified in the policy document to setup regional waste management facilities and island waste management centers and decentralizing waste management administration. Hence, the key policies relevant to this project include;

Policy 1: Establish a governance structure for solid waste management which will distribute clearly delineated roles and responsibilities for solid waste management at island, regional and national levels
Policy 2: All waste producers have a duty to manage the waste they generate
Policy 3: Waste will be management and disposed as close as possible to the place of their generation
Policy 8: Private sector participation (PSP) will be facilitated where it is financially for both government and private sector.

Establishing a proper mechanism of waste management and disposal will be vital for the overall operation of the project and the waste management practices both during construction and operation of the project will closely adhere to the policies and principles taken as a priority of the government.

5.8 AGRICULTURE POLICY

The MoFA is responsible for agriculture related policy development in the Maldives. The government recognizes the importance of agriculture as a viable means to diversify and expand the economy. The key agriculture development policies are:

1. Create awareness among individuals, groups, small and medium enterprises on the agricultural sector and provide technical, technological and financial assistance to farmers, especially women who grow crops in their homes as a livelihood to eliminate the possibility of a countrywide famine.
2. Assist and encourage farmers to determine crops that can be grown and cultivated at low cost and grow these in a manner that will help them to achieve financial self-sufficiency.
3. Facilitate the production of fertilizers using locally available materials. Inform farmers on sustainable energy sources, minimal usage of pesticides and chemicals as well as establish facilities to diagnose various plants and crop infections.
4. Provide the required assistance in marketing agricultural products and facilitate for the availability of seed and fertilizer at affordable prices in the agricultural regions of the country.
5. Expand the use of technology, such as hydroponics, in the agricultural sector to help develop and diversify the sector.

5.9 REGULATORY BODIES

5.9.1 Ministry of Environment and Energy (MEE)

The primary environmental institution in the Maldives is MEE. It is mandated with formulating policies, strategies, laws and regulations concerning environmental management, protection, conservation and sustainable development, regulation of the water, sewerage, waste and energy sectors as well as implementation of the international, regional environmental conventions and treaties. The Minister of Environment or a designate gives the environmental approval or clearance to EIA by an Environmental Decision Statement.

5.9.2 Environmental Protection Agency (EPA)

EPA is the key regulatory body on environment, which is an autonomous body formed under the umbrella of MEE. It is mandated with implementing the EIA process in the Maldives, implementing the Environment Act and subsequent regulations on behalf of MHE, regulating water and sanitation, biodiversity conservation, waste management and coastal zone management. Also, it is responsible for developing environmental standards and guidelines in the country.

5.9.3 Ministry of Fisheries and Agriculture

The Ministry of Fisheries and Agriculture is responsible for Agriculture legislation in the Maldives. The Agriculture legislation is implemented and enforced by the Agriculture Ministry. Under this Law, policies, regulations and guidelines have been developed in order to safeguard agriculture development and protection of agricultural resources in the Maldives. The Ministry's mandate is to ensure sustainable development of fisheries and agriculture sectors in the country.

5.9.4 Atoll Councils and Island Councils

Under the Maldives Decentralization Law, elected City Councils, Atoll Councils and Island Councils have been formed as regulatory bodies dealing directly with City, Atoll and Island issues. In this regard, the some of the development projects are subject to approval of these councils through a stakeholder consultation process.

5.10 LAWS AND REGULATIONS

There are a number of laws and regulations relating to environment in the country. Only relevant laws and regulations have been outlined in this section.

5.10.1 Environmental Protection and Preservation Act (Law No. 4/93) and Regulations

The Environmental Protection and Preservation Act of the Maldives, EPPA (Law No. 4/93) provides the basic framework for environmental management including Environmental Impact Assessment (EIA) process in the Maldives, which is currently being implemented by EPA on behalf of MEE.

Clause 2 of the EPPA mandates the Ministry of Environment and Energy to formulate policies, rules and regulations regarding the environment.

Clause 5 of this Act specifically provides for environmental impact assessment (EIA), a tool implemented to attempt to integrate environmental issues into development decisions. According to the Clause, environmental impact assessments are a mandatory requirement for all economic development projects.

Clause 6 of the EPPA gives the Ministry of Environment and Energy the authority to terminate any project that has an undesirable impact on the environment.

Clause 7 of the EPPA refers to the disposal of oil, wastes and poisonous substances in to the Maldivian territory. According to this clause, any type of waste, oil, toxic gas or any substance that may have harmful effects on the environment should not be disposed within the Maldivian territory. If, however, the disposals of such substances become absolutely necessary, the clause states that they should be disposed only within the areas designated for that purpose and if incinerated, appropriate precautions should be taken to avoid harm to the health of the population.

Furthermore, clause 9 sets a fine between five and five hundred Rufiyaa for minor offenses in breach of this law and a fine of not more than one hundred million Rufiyaa for major offenses. The fine shall be

levied by the Ministry of Housing and Environment or by other government authorities designated by that Ministry in case of minor offenses.
Finally, Clause 10 of EPPA gives the government of the Maldives the right to claim compensation for all damages caused by activities that are detrimental to the environment.

The Environmental Act or Law 4/93 is the single most important legal instrument with regards to environmental management and it gives very high prominence towards safeguarding the environment with regard to all the development activities. Under this Act, the Ministry of Housing and Environment have developed regulations and guidelines concerning the environmental protection through implementation of EIA procedures.

5.10.2 Agricultural Legislation

The MoFA has prohibited the logging of 20 species of plants. Prior written consent of MoFA has to be obtained for the felling of trees from the list.

MoFA also maintains the following requirements with regards to imported plants; plants brought into the country have to be quarantined and prior written consent is required from MoFA for import of plants and animals.

The type and amount of fertilizers imported for agriculture, landscaping and gardening purposes has to be approved by MoFA.

5.10.3 EIA Regulation of the Maldives, 2012

The most important regulation concerning the proposed development is Environment Impact Regulations, 2007, which was amended in 2012 is enforced under Environment Protection and Preservation Act (Law No. 4/93) by the Environmental Protection Agency (EPA). The Clauses of Environment Protection and Preservation Act address the following that relate to the proposed project development and implementation.

- An impact assessment study shall be submitted to the relevant Government authority before implementing any development project that may have a potential impact on the environment
- The relevant Authority of Government shall formulate the guidelines for environmental impact assessment and shall determine the projects that need such assessment as mentioned in above.
- The Termination of projects. The relevant Government Agency has authority to terminate any project that has any undesirable impact on the environment. A project so terminated shall not receive any compensation
- Waste Disposal, Oil and Poisonous Substances. Any type of waste, oil, poisonous gases or any substance that may have a harmful effect on the environment shall not be disposed within the territory of the Maldives
- Government of Maldives reserves right to claim compensation for all the damages that area caused by the activities that are detrimental to the environment.

In addition to EIA regulations, other relevant regulation will be followed in development and implementation of the proposed project. These regulations include ban on coral mining. Coral mining from house reef and atoll rim reef has been banned since 1990. Sand mining from any island has also been banned since March 2000. Coral or sand will not be used for any purpose for the proposed project.

5.10.4 Regulation on Uprooting, Cutting and Transportation of Palms and Trees, 2006

Cutting down and relocating of mature trees is regulated in Maldives under the By-law on Cutting down, Uprooting, Digging out and Export of Trees and Palms from One Island to Another. In the preamble of the law, made in pursuant to Law No. 4/93, it states the purpose of the law is to educate citizens and developers about the importance of trees including sound management to maintain trees and provide standards for the preservation of trees in the Maldives.

Under the law certain tree are prohibited to remove from island. They include:

- The coastal vegetation growing around the islands extending to about 15 m into the island
- All trees and palms growing in mangroves and wetlands spreading to 15 m of land area
- All trees in Government protected areas
- Trees that are being protected by the Government in order to protect species of animal / organisms that inhabit on such trees
- Trees / palms those are unusual in nature.

The regulation states that prior permission must be obtained for removal and/or relocation of 10 or more trees or palms. For indiscriminate removal and land clearances and EIA and Decision Note is required. The size of the trees and palms that are allowed to be relocated should have more 15 feet from lowest point to the crown spread for palms and 8 feet from the lowest point to the trunk to tip of the highest branch for trees other than palms.

The law also states that cutting down and uprooting of the trees shall be made under supervision of the island / atoll offices (in the current context Atoll / Island Councils).

5.10.5 Regulations on Tree Felling and Vegetation Removal

Enforcement of regulation on tree felling and vegetation removal started on 01 February 2006. This regulation has several clauses that will be binding on the developer during the construction and operation phases of this development. These include:

Article 2: Planting of two coconut trees for each coconut tree felled and planting of two trees for each tree felled in the island.
Article 3: Prohibition on the removal of any vegetation within 15 meters from beach.
Article 5: Requires an environment impact study before clearing of land for agriculture development.

The project has taken into account the above articles in the design of the site.

5.10.6 Hazardous substances act

Under the Hazardous Substances Act, prior written consent is required from the Ministry of Defence and National Security for import of chemicals to the country. The following information has to be submitted to the Ministry for approval of the chemical to be imported to the country:
Name of the chemical (in English), common name and principal trade name of the chemical, use (as insecticide/fungicide/rodenticide), country where it is being imported, amount that needs to be imported, reason for the import and if the chemical is retailed, name of the retailer.

Import of Class A chemicals into the country is banned and is listed in Table 7.

The Proponent shall obtain prior written consent of the Ministry of Defence for the import of chemicals. The project is designed to not use chemical fertilizers at any stage of this development.

Table 7: List of class A chemicals banned import into the country

Common Name	Trade Name
Insecticides/Acaricides	
Aldrin	Aldrex, Aldrite
Chlrodane	Chlorotox, Octachlor, Pentichlor
Endvin	Hexadrin
Dieldrin	Dieldrex, Dieldrite, Octalox
DDT (dichloro diphenyl trichloroethane)	Neocide, Pentachlorin, Chlorophenothate
Heptachlore	Dromex, Heptamol, Heptox
Mirex	
HCH (<99% gamma isomer)	Hexachlorohexane
Hexachlorobenzene	
Camphechlor	Toxaphene, Polychloro camphene
Nitrofew	
1,2 Dibromoethane	
1,2 Dichlorothane	
Monocrotophos	
Bromocholoromethane (CH2BrCl)	
Methylbromide (CH2Br)	
Fungicides	

5.10.7 Regulation on Management, Use and Control of HCFC Substances, 2010

The HCFC Regulation is developed under the Environmental Protection and Preservation Act (4/93) towards regulating phasing out of import, use, selling of HCFC substances by 2011 and completely eliminating use of HCFC substances in the Maldives by 2020 through controlling importers, registering importers, establishment of a quota system, control mechanisms for selling, maintenance of import, selling, purchase and service providers statistics. Under Ozone Layer Protection Act 14/2015 the government has banned import of HCFC based equipment starting from 31st May 2016.

5.10.8 Regulation on Environmental Damage Liabilities, 2011

Under the Environmental Protection and Preservation Act (No. 4/93), the Ministry of Housing and Environment formulated the Environmental Damage Liabilities Regulation in February 2011, which encompasses the basis to avoid environmental deterioration, extinction of biological resources, environmental degradation and avoid wastage of natural resources. The main purpose of this regulation is

to stop unlawful activities on environment and adequately implement a fining procedure for violations as well as implement a compensation mechanism on environmental damages. Its Schedules form the basis for levying fines on various environmental components and activities. Hence, the proposed project will be subject to this Regulation for any activity outside of the EIA scope and Environmental Decision Statement.

5.10.9 Dredging and Reclamation Regulation, 2013

Regulation on Reclamation and Dredging of islands lagoons (Regulation 2013/R-15) came into effect in April 2013. The regulation requires having permission of EPA on projects requiring alternation of the island, either by reclamation or dredging. Specifically the regulation requires producing scaled-maps of the island before and after the proposed intervention. Special provisions have been made on protected and sensitive area restricting changes to the environment of the islands.

According to the new enforcement arrangement made since November application for Dredging and Reclamation Permit for the projects has to be submitted along with the EIA/Addendums to the Environmental Protection Agency. Therefore the application for Dredging and Reclamation Permit for this project is submitted together with the EIA report.

5.10.10 Waste Management Regulation, 2013

Waste management Regulation (No. 2013/R-58) is more recent coming into effect on 6 February 2014. The Regulation was gazetted on 5 August 2013. The regulation is provides set of comprehensive guidelines and on collecting, storing, transporting and managing waste as well as management of hazardous waste. The waste management regulation identifies the following areas prohibited from dumping of waste; protected areas under the Environmental Protection and Preservation Act, mangroves, lagoons of islands, coral reefs, sand banks, beaches of islands, coastal vegetated areas of islands, harbours, parks and roads. Additionally, waste management regulation states that those involved in waste management must be permitted by the Environmental Protection Agency and waste can only transported on a vehicle that has obtained waste transportation licence and registered in EPA.

5.10.11 Other Environment-Related Laws and Regulations

Other laws and regulations that have direct bearing to environmental protection include, the Law relating to Uninhabited Islands (Law No. 20/89) and the Law relating to Coconut Palms and Trees of Inhabited Islands (Law No. 21/89), both define the policy with respect to conservation and use of terrestrial flora and living resources in the Maldives. The Law on Uninhabited Islands provides that trees and plants on uninhabited islands must be planted, cared for and protected by the party entrusted with the management of the island. Both these Acts regulate protection of vegetation, removal of trees and sustainable use of timber. The Law on Uninhabited Islands is implemented by Ministry of Fisheries and Agriculture, and the Law relating to Coconut Palms and Trees of Inhabited Islands is now implemented by Ministry of Home Affairs and Island Councils.

Coral and sand mining in the Maldives is regulated through Regulation of Sand and Coral Mining issued and implemented by Ministry of Fisheries and Agriculture. The Regulation restricts and prohibits mining of sand and coral from certain areas in the Maldives. It also identifies areas where mining of coral and sand is permitted through approval.

5.11 INTERNATIONAL REGIONAL CONTEXT

The major global issue facing the Maldives is climate change, global warming and subsequent sea-level rise. The small size of the islands and their low elevation above MSL makes possible impacts of it very seriously. Consequently, the country plays a prominent role in fore-fronting environmental issues faced by many other small islands developing states including the Maldives in the international arena. The Maldives is therefore, a party and signatory to various international conventions and declarations. These include;

- *UN Convention on the Law of the Sea – UNCLOS (1982)*
- *International Convention for the Prevention of Pollution of the Sea by Oil (1982)*
- *Vienna Convention for the Protection of the Ozone Layer (1985)*
- *Montreal Protocol on Substances that Deplete the Ozone Layer (1987)*
- *Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal (1989)*
- *The London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1990)*
- *Agenda 21 and the Rio Declaration of the United Nations Conference on Environment and Development (1992)*
- *Convention on Biological Diversity (1992)*
- *United Nations Framework Convention on Climate Change (1992)*
- *The Copenhagen Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1992)*
- *The Montreal Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1997)*
- *The Beijing Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer (1999)*
- *Washington Declaration on Protection of the Marine Environment from Land-Based Activities*
- *Kyoto Protocol to the United Nations Framework Convention on Climate Change (1998)*
- *Cartagena Protocol on Biosafety (Maldives acceded on 2 September 2002)*
- *United Nation Convention to Combat Desertification (2002)*
- *Convention in International Trade in Endangered Species of Wild Fauna and Flora (CITES) 2013*

The Maldives is also a key player in formulating and adopting various regional plans and programmes to protect the environment by continuously participating in various activities organized by regional bodies such as SACEP, ESCAP and SAARC. As a result the Maldives is committed to the following;

- *SAARC Environment Action Plan adopted in 1997 in Male'*
- *SAARC Study on Greenhouse Effect and its Impact on the Region*
- *South Asian Regional Seas Action Plan and Resolutions concerning its implementation (1994)*
- *SAARC Study on Causes and Consequences of Natural Disasters, and*
- *South Asian Seas Programme initiated by SACEP*
- *Male' Declaration on Control and Prevention of Air Pollution and its likely Transboundary Effects for South Asia (1998)*

6 EXISTING ENVIRONMENTAL CONDITIONS

6.1 GEOLOGY AND GEOGRAPHY

Gadhdhoo reef is located on the SW corner of Huvadhoo atoll (Figure 5). The reef system over which the project islands exists comprises of six other reef islands; Maavaarulu, Kondaanahutta, Farehulhedhoo, Kalhemamal, Maavadhuvaa and the inhabited island of Gadhdhoo (Figure 20). Of the 10 islands on the reef complex 1 is an inhabited island with a large population and all others are uninhabited.

Four island Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa are vegetated islands (three islands Hulhuvaarulaa, Menthandhoo, Golhaalaa are sand cays and Dhoonirehaa is a rubble cay) situated on the south eastern rim of Gaafu Dhaalu (Gdh) Atoll. The cluster of four islands are located on the northern half of Gadhdhoo reef, which is a large reef platform over 10km long with varying width ranging between 1-1.8km. The total area of the reef platform is 14.5km^2. Geographic location of Hulhuvaarulaa Island is at approximately 73°29'13.69"E, 0°19'40.61"N, Mendhandhoo at 73°29'30.75"E, 0°19'28.32"N, Golhaalaa 73°29'10.50"E, 0°19'13.54"N and Dhoonirehaa is at 73°29'39.06"E, 0°19'28.01"N.

Gadhdhoo is the nearest inhabited island located on the south eastern end of reef platform approximately 4.5km south of the island cluster. There are total of 10 islands sharing the same house reef with the cluster of four islands. Maavaarulaa where an airstrip is being developed is located 2km away from the island cluster on north eastern end of the reef platform.

Hulhuvaarulaa is an elongated island located on the western side on the central part of the reef platform. Golhaalaa and Menthandhoo are separated islands lied parallel to Hulhuvaarulaa on the east close to ocean-ward eastern reef rim. A semi open shallow water body exists at the center between the three islands, Hulhuvaarulaa, Menthandhoo and Golhaalaa. This water body is ecologically significant as it provides calm shelter for large number of fish particularly rays and juvenile sharks and other types of benthic and burrowing fish species. Large part of this area is coved with a very shallow seagrass bed. The whole area is exposed at low tide.

Dhoonirehaa is a small vegetated shingle cay located on the north eastern end of Menthandhoo separated by a 1m wide shallow channel exposed at low tide. Major developments of the proposed project, particularly necessary and important infrastructures, harbour, power station, water and oil storage, accommodation and 3 hectares of greenhouse, will be developed on Hulhuvaarulaa in Phase I. Deep seawater cold water distribution system and pumps will be developed on Dhoonirehaa, the closest island to the open ocean.

The reef system has a relatively shallow reef flat that has an average depth of approximately 0.5-2 m (MSL). The atoll-ward slope of this reef system has a sandy slope scattered with coral habitats and there is no Vilu (deep lagoon) within this reef system, which is a common feature found on most peripheral reefs of Maldives.

Figure 20: Gadhdhoo reef and the four islands proposed for the development

6.2 OBJECTIVES

The purpose of study was to assess the existing environmental conditions of the island, including marine and land environment. Further, study of existing environment also involved undertaking review of available literature to understand long term trends in climatological regime and natural hazard incidents. These assessments would not only enable avoiding impacts to the environment as a result of the project but also would contribute to better planning recommendations for the proposed project. This is critical in assessing potential impacts and to determine the actual extent of damage should an unforeseen impact occur during the implementation phase.

The main aim of surveys and assessments was to establish the existing baseline environmental conditions of the four islands and the surrounding reef platform. Environmental monitoring during construction and operation phase of the islands to ensure the changes in environment are captured and remedial actions for the observed negatives impacts are addressed in a timely manner. The objectives of the present assessment were to:

1. Determine the general abiotic and biotic conditions of the terrestrial and marine environment of the project area and surroundings;
2. Determine the geological and geomorphological characteristics of the project area;
3. Assess the changes that will be associated with the proposed project;
4. Propose mitigation measures to avoid, minimise potential effects from the proposed project; and
5. Propose monitoring arrangements to measure effectiveness of the proposed mitigation measures

6.2.1 Study Area and Survey Locations

Figure 21 shows the vegetation, ground and sea water sampling locations, beach profile and marine survey locations with their respective GPS co-ordinates of profile locations and water samples are given in respective sections of the report.

6.3 METHODOLOGIES

6.3.1 Terrestrial and marine environment:

Cloud free DigitalGlobe™ multi spectral and pan chromatic satellite images of the islands and reef taken on 13th April 2006 was obtained. Ground resolution of DigitalGlobe™ (near-vertical observation)

panchromatic is 0.6m, the multi spectral (colour) is 2.4m with a swath width of approximately 12km. The following gives characteristics of the satellite image.

Panchromatic (Black and white)
Wave length: 500 ~ 900nm
Ground resolution (near vertical observation): 0.6 meters
Multi-Spectral (colour)
Ground resolution 4m
Spectral regions:
(Blue) 430~545nm
(Green) 466~620nm
(Red) 590~710nm
(NIR) 715~918 nm

Remote sensing and GIS techniques were used for satellite data analysis and unsupervised classification of the vegetation, reef and substrate composition, which was later validated in the field. The proposed plan, existing island and aerial photographs were overlaid along with the classified image to identify critical areas of the island that fall into the proposed development plan in the four islands.

The islands were visited from 26-31 January 2016 for field data collection. During the field ground control points (GCPs) were collected and the image was georeferenced. Ground truthing of classified satellite image and identification of features of interest to locate representative areas of each feature in order to generate spectral signatures of that particular feature both in terrestrial and marine environment. Field data was processed, satellite image was validated and a supervised classification of the image was carried out. Existing island and proposed plan were overlaid and critical impact areas were identified, and relevant maps were generated.

Vegetation Assessment: Satellite data was used for vegetation assessment and vegetation classification by using remote sensing and GIS techniques. Both qualitative and quantitative information on vegetation type and cover after ground truthing in the field.

Soil and groundwater Assessments: Three ground water samples were collected from Hulhuvaarulaa, Menthandhoo and Golhaalaa in clean 1.5 L PET bottles after washing them with water to be sampled, as the major developmental activities will be concentrated on these three island. Islands. Parameters tested for ground water quality assessments were physical appearance, temperature, pH, electrical conductivity, total suspended solids. Necessary parameters to assess the overall quality of the ground water was analysed at the laboratory in Male' Water and Sewerage Company (MWSC) laboratory location of sampling area given in Figure 21.

Soil structure of the islands were assessed from three wells one well in each island dug to extract ground water sample (Figure 21). Given the time constraints, during the field studies only the physical aspects of the Island soil were considered. However, due to the similar nature of oceanic island soils throughout the world, certain generalizations with regard to soil chemistry for the Island have been made based on similar studies done for other island soils of the same geomorphologic aspects. Soil profiles were done by digging 2 x 2ft pits at the center of the island, and the horizontal dimensions of the horizons measured using a meter tape. Sections from different horizons were also removed to study the important physical properties of the soil succession.

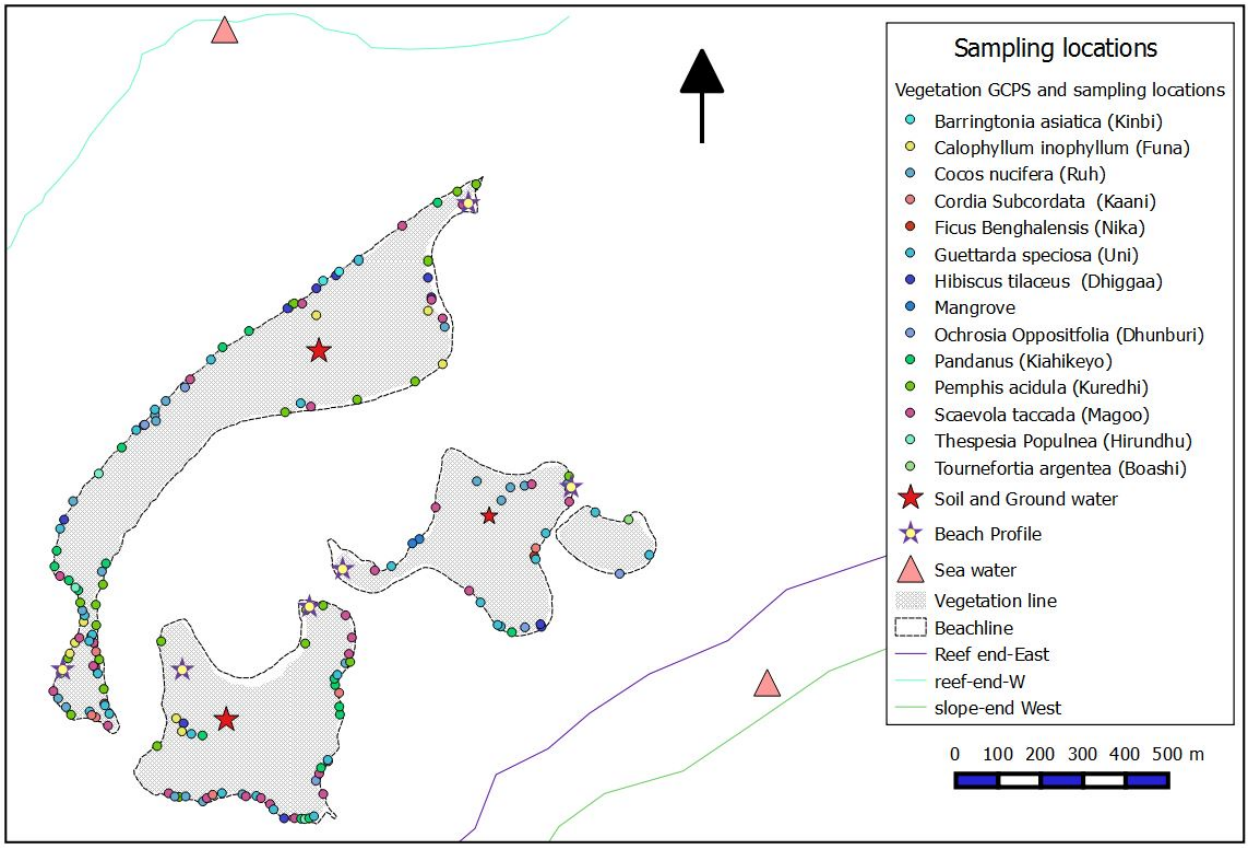


Figure 21: Sampling location map showing the GCPs collected for the vegetation classification, soil sea and ground water sampling points and beach profile locations

6.4 GEOLOGY AND GEOMORPHOLOGY

Aerial photographs and Digital globe, Google Earth and island surveys are comparatively evaluated using GIS technology to assess the long-term changes and developments of the island. Six beach profiles were taken from Hulhuvaarulaa, Menthandhoo and Golhaalaa two from each island during the field visit to establish baseline for beach monitoring in the future. The beach profiles are taken from sand spits which is considered to be the most dynamic areas of the island.

6.5 BATHYMETRY

Bathymetric survey of the reef system shallow water was carried out by using echo sounder and a GPS. Post processing differential corrections is used for correction of GPS locations points. Echo sounder measurements are corrected and related to the mean sea-level for the area. Shallow water bathymetry of the Falhu is given in Figure 22.

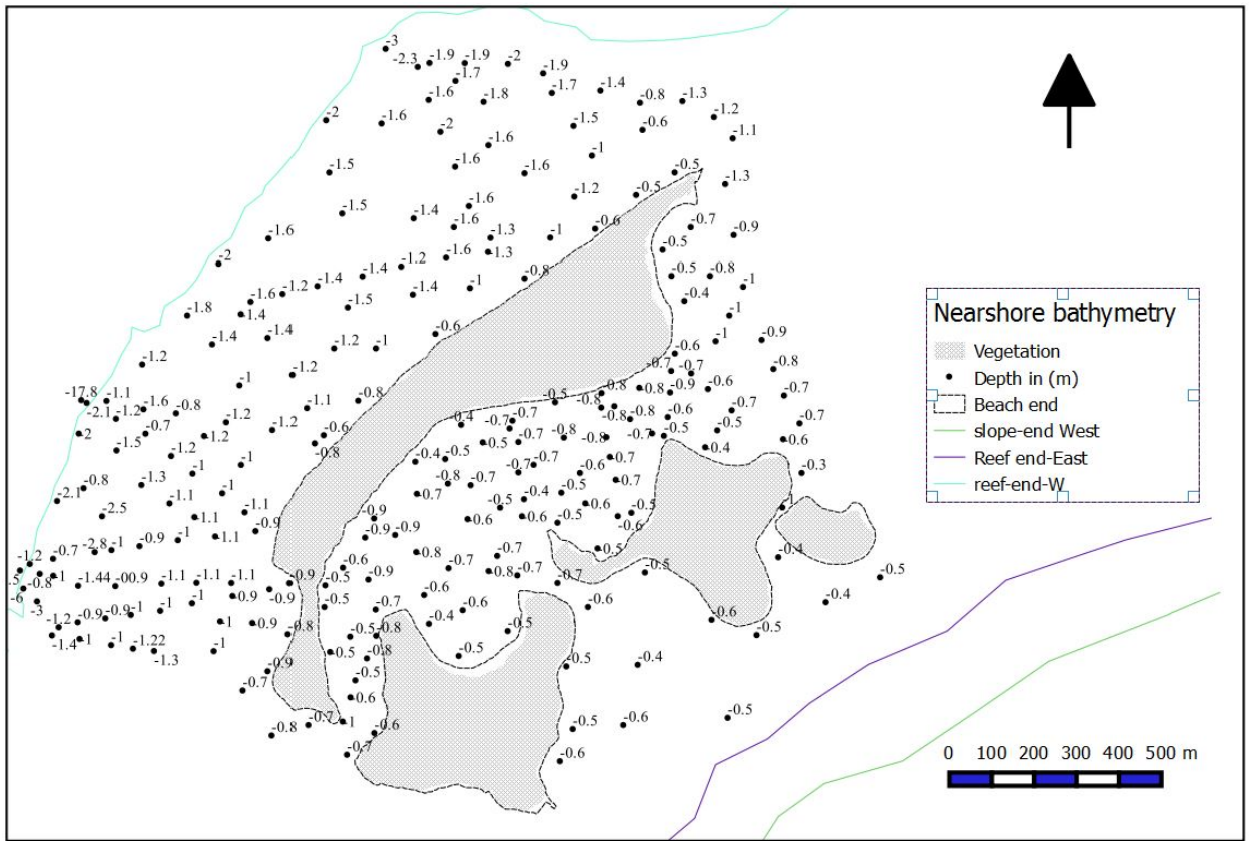


Figure 22: Nearshore bathymetry of the area

Preliminary deep water hydrographic survey of the ocean was also carried to determine the depth of occurrence of cold water and seabed profile to lay the deep water intake pipeline Figure 23.

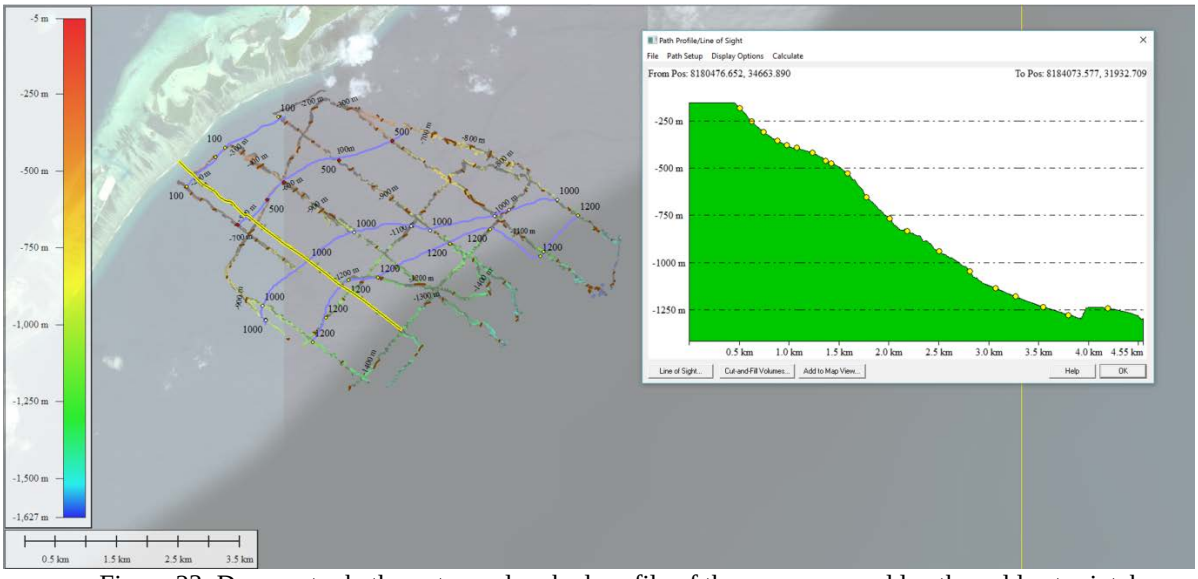


Figure 23: Deep water bathymetry and seabed profile of the area proposed lay the coldwater intake

Marine Water Quality: Water sample was obtained from the lagoon on the western side of Hulhuvaarulaa, and eastern reef of Dhoonirehaa where the seawater intake and outfall will be laid.

Sample was taken in a plastic bottle after washing it with seawater obtained from the same location. The sample was kept in low temperature. Analysis was carried out at MWSC laboratory using certified methodology.

6.6 METEOROLOGY AND CLIMATE

6.6.1 Temperature

The daily average temperatures rarely drop below 25°C and rarely go above 32°C. The warm period of the year is from March to May with an average daily high temperature above 31°C. The hottest day of the year is during April, with an average high of 32°C and low of 28°C.

The cool periods lasts from October/November to January with an average daily high temperature below 30ºC. The coldest day of the year is around mid-December, with an average low of 26°C and high of 30ºC. The sea surface temperature in the Indian Ocean in July 2014 is recorded to be around 29-30ºC.

6.6.2 Rainfall

The four islands of the project are located in a high rainfall zone of the country. Rainfall data from the three main meteorological stations, HDh Hanimaadhoo, K. Hulhule and S. Gan shows an increasing average rainfall from the northern regions to the southern regions of the country. The southern atolls receive, on average, 2,277 mm of rainfall annually, while the relatively drier northern atolls receive 1,786 mm (MMS, 2006). The nearest meteorological station to the four islands is at Kaadedhoo airport which became operational relatively recently in 1993. Rainfall data for the period 1994 – 2012 from Kaadedhoo has been used to determine rainfall pattern for project Island.

The mean annual rainfall for Kaadedhoo is 2186.6 mm with a Standard Deviation of 398.1 mm and the mean monthly rainfall is 182 mm. Mean rainfall varies throughout the year with mean highest rainfall during October, November and December and lowest between February and March (See Figure 24).

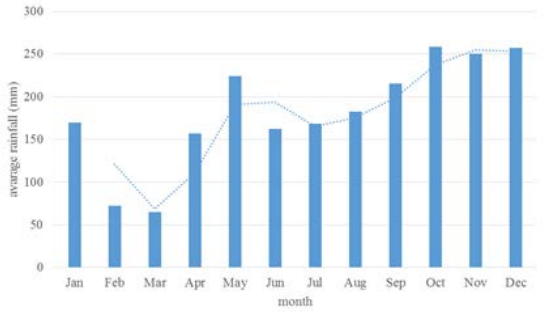


Figure 24: Average monthly rainfall Kaadedhddhooo 1991-2012

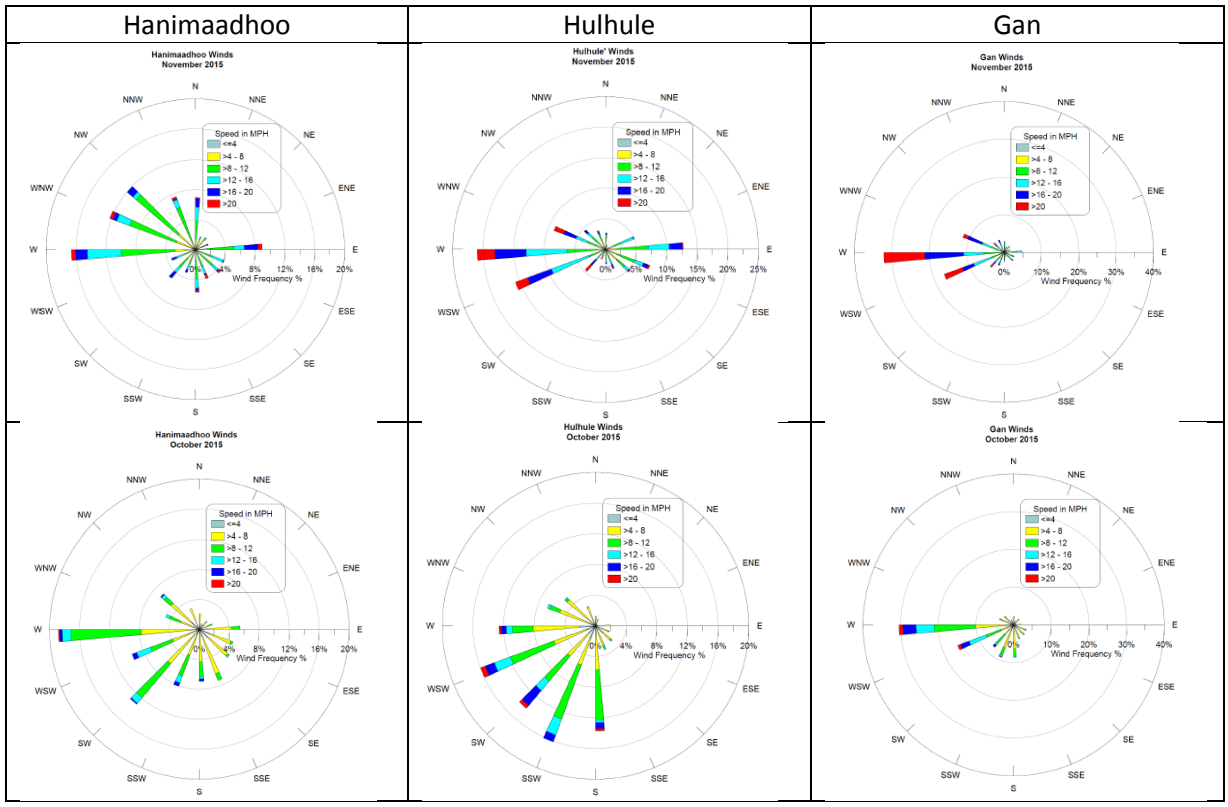
Available severe weather event records shows that Kaadedhdhoo received a maximum precipitation of 219.8 mm for a 24 hour period on 10th July 2002, the highest recorded anywhere in Maldives since recording began. This event caused widespread damage or disruption to personal property, road infrastructure, sewerage infrastructure, backyard crops, harbour quay wall, school operation and businesses in Gadhdhoo Island nearest inhabited island. During the flooding events of November 2003, the recoded rainfall in Kaadedhoo for the 24 hour period was 64.4 mm (DoM, 2005). A month later, rainfall up to 60.3 mm was observed. These two events caused disruption to businesses, school and minor damage to household goods in Gadhdhoo Island.

6.6.3 Monsoons

The climate of Maldives is characterised by the monsoons of Indian Ocean. Monsoon wind reversal significantly affects weather patterns. Two monsoon seasons are observed in Maldives: the Northeast (Iruvai) and the Southwest (Hulhangu) monsoon. The parameters that best distinguish the two monsoons are wind and rainfall patterns. The southwest monsoon is the rainy season while the northeast monsoon is the dry season. The southwest monsoon occurs from May to September and the northeast monsoon is from December to February. The transition period of southwest monsoon occurs between March and April while that of northeast monsoon occurs from October to November.

6.6.4 Winds

The climate of the Maldives can be divided into two monsoon periods marked by strong seasonal reversals in wind direction that are confined to a narrow range of wind angles. General wind pattern across Maldives indicate that the Maldives experience west to northwest winds (2250–3150) from April to November during the Hulhangu monsoon with a mean wind speed of 5.1 m s-1. In contrast the Iruvai monsoon, from December to March, is characterized by winds from the east-northeast (450–900) with a mean wind speed of 4.9 m s-1. Within these general wind directions, regional variation across Northern Central and Southern Maldives can be observed in Figure 25 from the wind records of 2015 June to November (DOM).



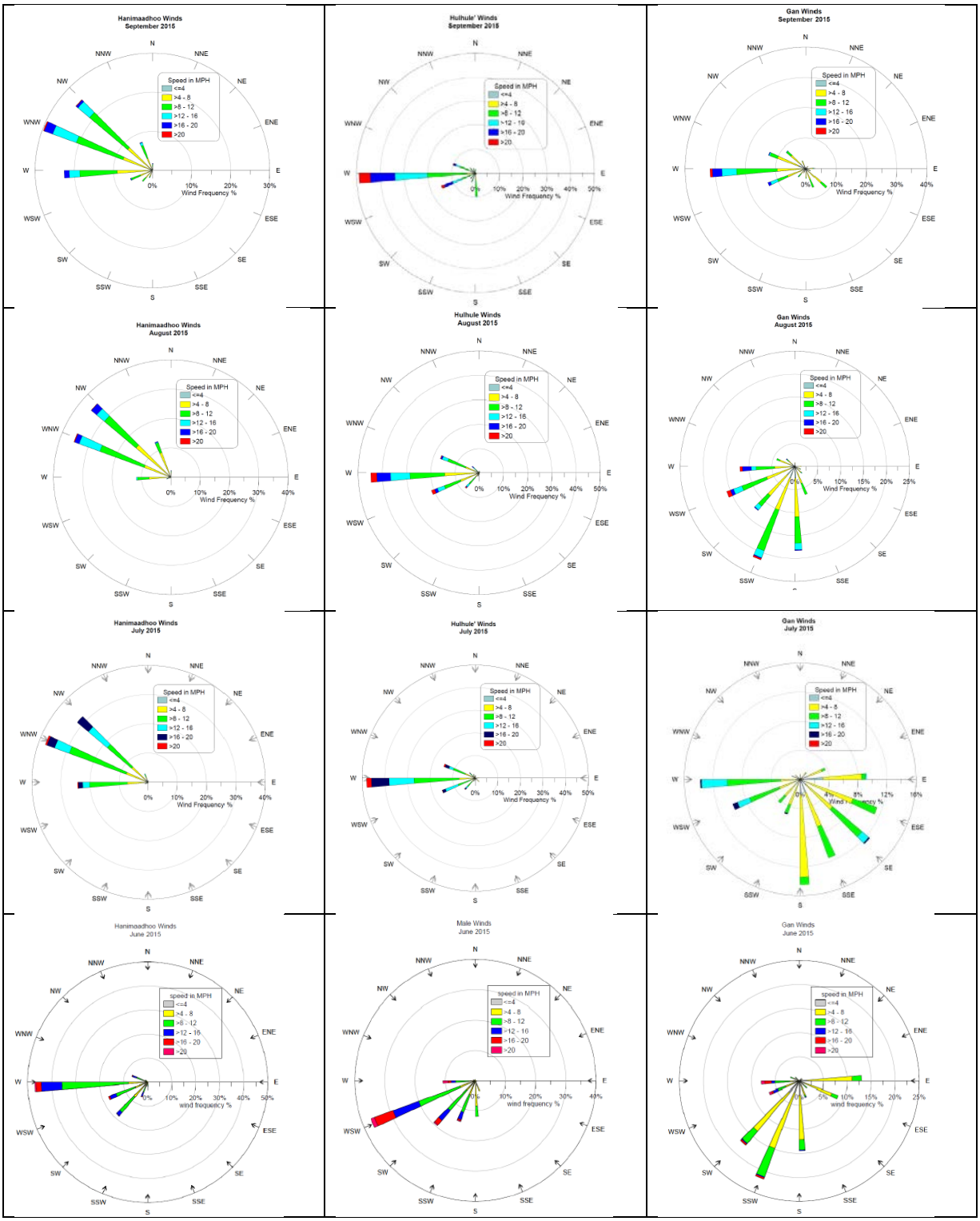


Figure 25: Variations in wind direction and frequency June-December 2015 North, Central and Southern Maldives (Department of meteorology)

The data shows that the southern part of the Maldives experienced over 20MPH speed wind during November 2015 from westerly direction. While during the period of Jun-Nov 2015 wind speed is in the range of 4-12MPH from southern and westerly directions.

6.6.5 Hydrology

Waves

Satellite altimetry derived wave climate data over a ten-year period for the Maldives region (Young, 1999) indicates the dominant swell approaches from southerly directions. On a seasonal basis, swell is from the south-southwest from April to November with a peak significant wave height (Hs) of 1.8 m in June, and from the south to southeast directions from November to March with minimum Hs of 0.75 m in March (Figure 27). Overall wave energy was greatest on all islands during the westerly monsoon (Young, 1999).

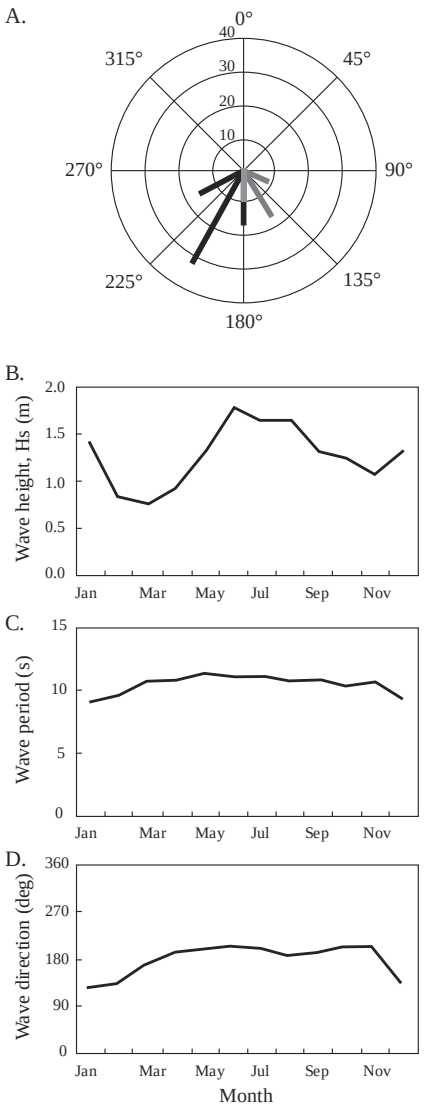


Figure 26: : Ten year mean monthly ocean swell for the Maldives showing (A) wave direction for April to November (black lines) and December – March (grey lines) (B) wave height (C) wave period (D) wave direction. Data from Young (1999) adapted from Kench and Brander, (2006).

Wind analysis show that for much of the year (April to November) stronger wind generated waves approach the islands from southerly direction. During December to March wind generated waves approach the project location mainly from the easterly direction (Figure 26). The four islands are exposed to swell waves approaching from easterly and north easterly direction. Hence during the north easterly monsoon waves could directly affect the eastern coastal boundary of the island. Intensity of swells during the north easterly monsoon is estimated to be high due to location of the islands on the out atoll rim.

Tide

The Maldives is subjected to a semidiurnal microtidal regime with spring and neap tidal ranges of 1.2 m and 0.6 m respectively. The highest astronomical tide was recorded as 0.64 m above the mean sea level and the lowest astronomical tide was recorded as 0.56 m below the mean sea level. Tidal variation of 1.2 m from lowest to the highest tide levels were recorded in the country (see Table 8). This suggests that there is a maximum clearance of structures of 0.9 m above maximum tidal limit. Tidal fluctuations (rise and fall of tides) cause changes in current flow pattern around the island and bring subsequent changes in physical aspects of the shoreline. At low tide water movement is very slow, therefore low tide period is considered to be a good time to conduct dredging and reclamation work.

Table 8: Tidal variations for the Maldives related MSL

Tide Level	*Referred to MSL*
highest astronomical tide (HAT)	+0.64
mean higher high water (MHHW)	+0.34
mean lower high water (MLHW)	+0.14
mean sea level (MSL)	0.00
mean higher low water (MHLW)	-0.16
mean lower low water (MHLW)	-0.36
lowest astronomical tide (LAT)	-0.56

Surface Currents

Currents which affect the sea area around the Maldives are caused by one or more of the following systems:

a) Oceanic currents
b) Tidal currents
c) Wind-induced currents
d) Wave-induced currents

The oceanic currents flowing across the Maldives are notorious for their strength. The exposure of the Maldives to the vast Indian Ocean ensures that an immense body of water is constantly flowing across the plateau on which the atolls are built. In the Arabian Sea, as one gets closer to the equator, the prevailing winds become more and more indicative of the oceanic surface current. Thus, wind (especially during monsoons) can be a major factor affecting current velocity and direction, and currents can be of great strength (wind-induced currents). For example: currents in the channels near Malé have been recorded at 4 knots or more. Inside an atoll, current speeds are more settled. Oceanographic currents are driven by two monsoonal winds, namely the westerly and north easterly wind. The westerly flowing current tend to dominate from January to March while the easterly currents dominate from May to November. The changes in current flow patterns occur in April and December.

The vertical water movements associated with the rise and fall of the tide are accompanied by horizontal water motion termed tidal currents. These tidal currents have the same periodicities as the vertical oscillations, but tend to follow an elliptical path and do not normally involve simple to- and-from motion. Generally the tidal currents are eastward in flood and westward in ebb. Tidal currents, which flow according to the height of the tide, are generally not strong. There is a strong diurnal influence, which governs the tides in the Maldives, but in general the tidal range is less than 1m.

On a more local scale, especially on the reef flats, wave-induced currents (cross-shore and/or long-shore) also form an important factor affecting the current regime.

Data on current speed and direction around the islands were measured during the field visit. However, spot data taken on a single day would not yield sufficient data to understand coastal dynamics. Therefore, long term monitoring of data will be recommended in the monitoring programme proposed for the development.

6.7 NATURAL HAZARDS

Natural hazards that may occur at the project location can be broadly classified into geological and meteorological hazards. Based on the different types of hazards identified in Detailed Island Risk Assessment for the Maldives (DIRAM) (UNDP, 2008), the following hazards have been predicted to be particularly relevant to the project site in relation to the project components:

- Windstorm;
- Flooding due to heavy rainfall/storms;
- Gravity waves (swell waves and *udha*); and
- Tsunami

UNDP's Detailed Risk Assessment carried out for Villingilli and Thinadhoo Island which shares the same atoll has been applied to predict natural hazards of the four islands.
DIRAM that the major natural hazards in the Maldives are strictly controlled by the geophysical and climatic settings and show quite different patterns in their distribution, as shown in Figure 27.

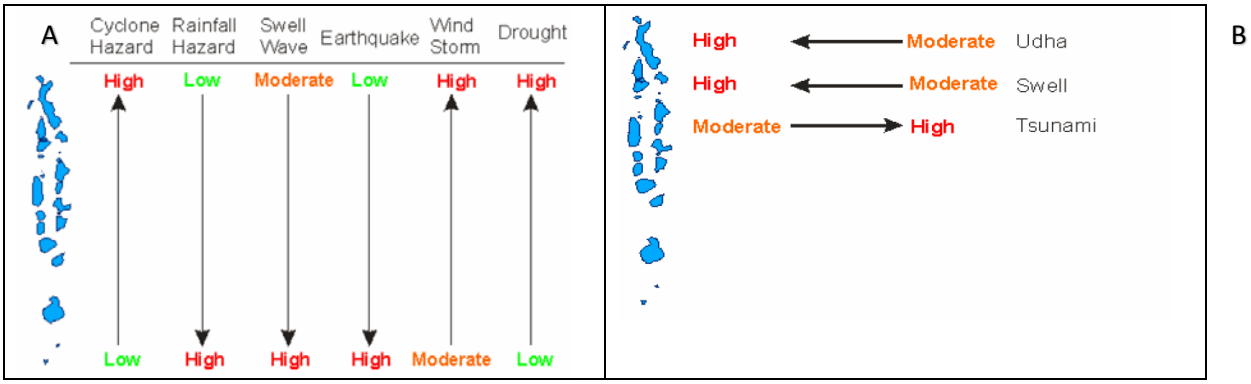


Figure 27: Major natural hazards distribution pattern in the Maldives. (A) Latitudinal variations of major natural hazards. (B) Longitudinal variations of major natural hazards across the Maldives. (Adapted from UNDP, 2008).

As can be seen in Figure 14, the tropical cyclones and correspondingly storm surges predominantly prevails in the north of the Maldives. In contrast, swell waves and heavy rainfalls are more prominent in

the southern and western islands of the Maldives. The southern islands of the Maldives are threatened by earthquakes from the seismic zone of Carlsberg Ridge. Considering the longitudinal variations in hazard distribution the eastern rim islands are subject to tsunamis and waves of a higher intensity due to their direct exposure to these hazards, whereas the western rim and atoll lagoon islands are protected by the atoll formation patterns. Islands in the south are more exposed to southwest monsoon related surges and long distance swells originating from the southern Indian Ocean. Islands in the north are more exposed to storm events and their impacts including storm surges and strong wind (UNDP, 2008).

6.7.1 Rain Floods

Based on historical records it has been determined that flooding caused by heavy rainfall as the most commonly occurring hazards in the region. According to records of Gadhdhoo, inhabited island located in the same reef with the four islands, heavy rainfall related flooding is common during mid-to-late southwest monsoon. These events are reported to cause heavy flooding in Thinadhoo and Villingilli (UNDP, 2008)..

6.7.2 Udha

Flooding can occur by a gravity wave phenomenon known as Udha. These events are common throughout Maldives and especially the southern atolls of Maldives during the southwest monsoon. Impacts of Udha events are expected to be highest on the western rim island due to the south westerly and westerly approach of these events. The intensity and impacts of Udha waves are usually very low with flooding occurring within 5-10 m of coastline at less than 0.3 m height above the ground. Therefore, it is not expected to be a high intensity hazard in the short-term. It is highly probable that waves originate as swell waves from the Southern Indian Ocean and is further fuelled by the onset of southwest monsoon during May. The timing of these events coincides the onset of southwest monsoon. The concurrent existence of Udha and swell waves during the southwest monsoon is confirmed by Kench et al (2006) and DHI (1999).

6.7.3 Strong Winds

Windstorms have also been reported as frequent in Huvadhoo Atoll region especially during the southwest monsoon, causing damages include falling trees, damage to crops, and structural damage to roofs. Strong wind is a phenomenon that occurs during monsoon season, mainly due to depression and cyclonic activity in the region. Strong wind causes high tides which lead to surge in coastal areas and these winds affect transportation and damage boats and vessels (UNDP, 2008). Occasional strong monsoonal activity or localised low depressions generate wind speeds capable for causing substantial damage to vegetation and weak housing structures. Based on the DoM reports, the maximum wind speed experienced in Kaadedhoo is 96km/h. These are extremely high wind speeds and are equivalent to those experienced in a category 2 cyclone, according to the Beaufort scale (UNDP, 2006). The intensity of the strong wind across the island is expected to remain fairly constant.

6.7.4 Cyclonic Storms

With regards to cyclones hazards, 11 cyclones crossed the Maldives during the last 128 years, most of the cyclones passed over the north of the country (UNDP, 2006). Cyclonic hazard zonation map has been developed based on past records in Maldives and threshold levels for various wind speeds and its impact on Maldives has also been developed on the basis of interviews with locals and available meteorological data. According to UNDP (2008), there are no records of cyclones for the southern region, although a number of gale force winds have been recorded due to low depressions in the region. Winds exceeding 34 knots (gale to strong gale winds) were reported in Kaadedhoo annually between 2002 and 2005; all caused by known low pressure systems near Maldives, rather than the monsoon. Entire Ga and Gdh Atoll lies in the low hazardous zone with respect to cyclone related hazard.

6.7.5 Storm Surge

Huvadhu Atoll is subjected to frequent flooding caused by wave surges and sometimes large swell waves generated far offshore from the coasts of the Maldives. Historical data on storm surge events shows records of at least 8 events since 1960s (UNDP 2008). These events are also reported to occur during mid-SW monsoon. Available literature indicates maximum storm surge height to be 1.32 m and if coupled with high tide, it could generate a storm tide of 2.30 m. The geographical and natural setting of the four islands being located on the south eastern rim of Huvadhu similar pattern can be expected. Despite, being protected from the predominant swell wave patterns but being very close to the reef edge Dhoonirehaa, Menthandhoo and Golhaalaa are exposed to abnormal swell waves originating from intense extra-tropical storms in the southern hemisphere between 73°E and 130°E longitude. Waves generated from such abnormal events could travel against the predominant swell propagation patterns in the Indian Ocean (Goda, 1998), causing high energy wave conditions from the eastern side. Historical flood events recorded for Gadhdhoo and the islands on the eastern periphery of the atoll are most likely to be the result of such waves (Figure 28).

Figure 28: Storm Surge Hazard Zones with Cyclones Affected (Adapted from UNDP, 2008).

Based on the historical events UNDP (2008) predicts that there is a probability of major swell events occurring every 10 years on the eastern and south southeastern part of the atoll, with probable water heights of less than 1.0 m and every 5 years with probable water heights of 0.5-0.75 m. Events with water heights less than 0.5 m and greater than 0.2 m are likely to occur once every 2-3 years. The timing of swell events is expected to be predominantly between April to October, based on historic events and storm event patterns.

Monsoonal wind generated waves are believed to be more consistent in approach and effect on the island coast. The eastern rim islands of Huvadhoo Atoll, is generally exposed to wind generated waves during the northeastern monsoon between November and March, with heights less than 2.0 m and wave periods of 2 -4 seconds. The western coastline is exposed to wind generated refracted and reflected fetch waves originating within the atoll due to the 30 -50 km fetch, usually averaging less than 0.5 m. The western coastline may receive residual swell waves penetrating the atoll through atoll passes.

7 TERRESTRIAL ENVIRONMENT

7.1 INTRODUCTION

Following is an account on the existing status of the terrestrial environment of Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa based on field data obtained during field assessments undertaken on the island supplemented by DigitalGlobe™ satellite data.

7.2 STATUS OF FLORA

Vegetation on the four islands is different because the nature of the soil content mainly Menthandhoo, Golhaalaa and Dhoonirehaa are different from Hulhuvaarulaa. Golhaalaa and Dhoonirehaa are vegetated shingle cays (rubble cays) and the eastern part of Menthandhoo is also dominated by rubble. Existing remnant of shingle cay beach rock on the eastern edge of the three islands can be considered as fossilised islands that clearly shows how the shingle cay was initiated and sheltered for the islands to grow west wards. Hulhuvaarulaa formation is completely different form the rest of the islands as the main soil content of the island is calcareous coral sand hence the vegetation succession of the island is more or less similar to the majority of islands in the Maldives. In the three islands that are facing the semi enclosed water bodies, vegetation facing the water body (eastern side of Hulhuvaarulaa, western side of Menthandhoo and Golhaala have similar vegetation type, where the outer layer consists mainly of, *Pemphis acidula* (kuredhi), *Tournefortia argentea* (boashi) *Pandanus tectoris* (Boakashikeyo) *Scaevola taccada* (Magoo) with occasional *Guettarda speciosa* (Uni), *Hibiscus tilaceus* (Dhiggaa) and *Calophyllum inophyllum* (Funa), Ochrosia Oppositfolia (Dhunburi), Cordia Subcordata (Kaani) Thespesia Populnea (Hirundhu), Ficus Benghalensis (Nika). Coconut palm *Cocos nucifera* is scattered in various parts of the three islands Hulhuvaarulaa Menthandhoo and Golhaalaa and abundant mostly in the inner and central parts of the three islands. Few *Barringtonia asiatica* (Kinbi) trees were encountered in Hulhuvaarulaa and two Mangrove trees were found on the western side Menthandhoo. Only few coconut palms are observed in Dhoonirehaa.

Ground control points (GCPs) of the identified tree species from the islands were marked and samples location and sizes were noted and used for vegetation classification of the islands. GCPS used for vegetation and sampling locations are shown in Figure 21. Supervised vegetation classification tool of QGIS® Open source GIS Software was used and vegetation cover of each type was calculated using GIS. Classified vegetation map was then overlaid with the development foot print to estimate the type and cover of trees that falls into the area proposed for development in each island. Figure 29 shows the vegetation classification and the Table 9 shows the vegetation cover area of each type of dominating tree types in each island and tree types that fall in the development footprint in each island.

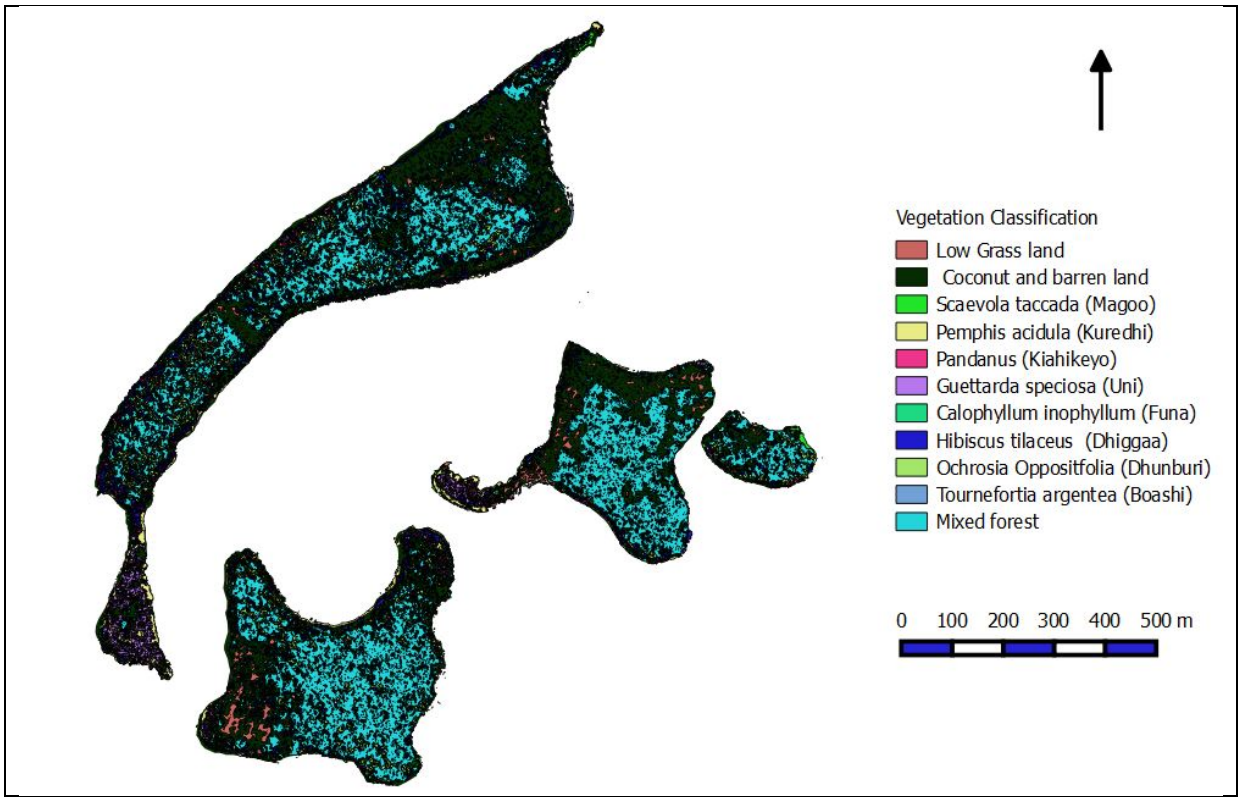


Figure 29: Vegetation classification of Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa

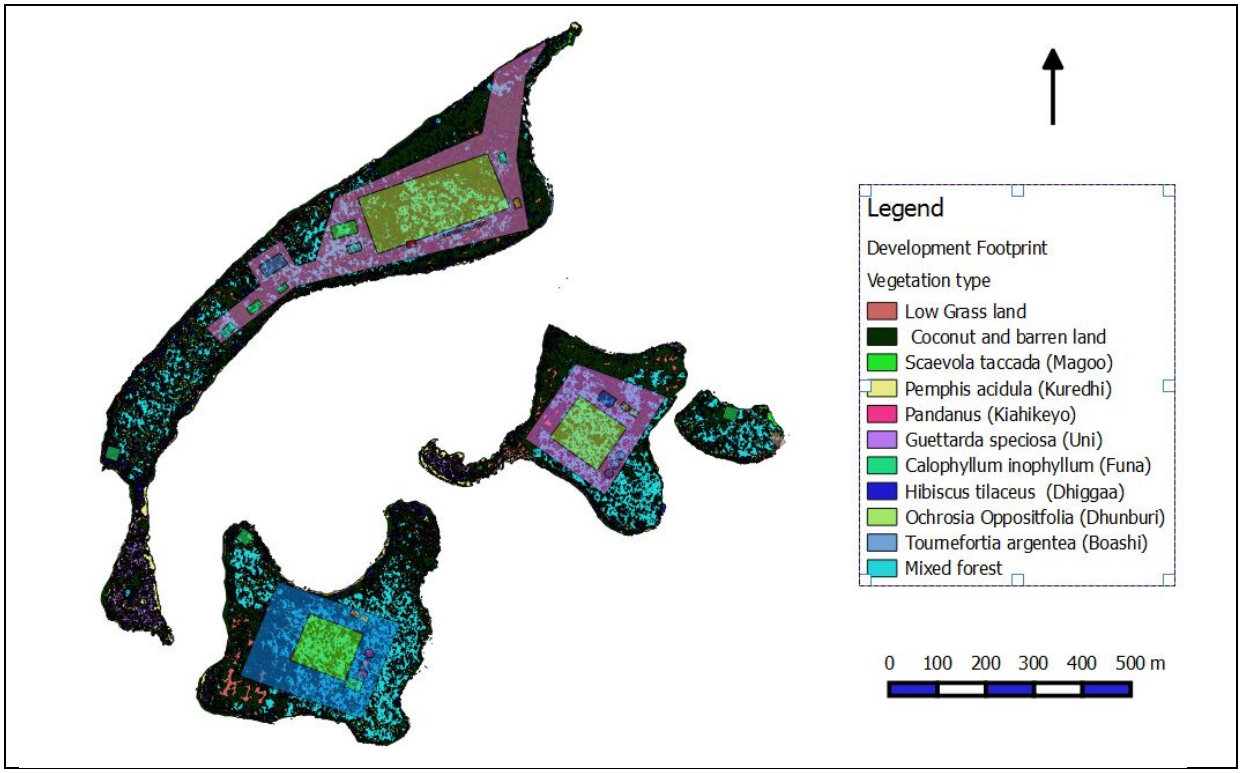


Figure 30: Development footprint and the types of trees that fall into the areas proposed for land clearance in the four islands see the details in Table 9.

Table 9: Type of vegetation cover and tree types that fall into development foot print

	Hulhuvaarulaa				Menthandhoo				Golhaalaa				Dhoonirehaa			
Vegetation Class	Cover area (m^2)	% Cover	Footprint area (m^2)	% of cover fall in Foot print	Cover area (m^2)	% Cover	Footprint area (m^2)	% of cover fall in Foot print	Cover area (m^2)	% Cover	Footprint area (m^2)	% of cover fall in Foot print	Cover area (m^2)	% Cover	Footprint area (m^2)	% of cover fall in Foot print
Low grass land	3238.92	1%	1034.28	32%	4825.34	5%	1947.86	40%	4401.61	3%	1902.14	43%	154.08	0%	99	64%
Coconut	29023.7	12%	3573.99	12%	11312.86	11%	1975.75	17%	22093.03	15%	1974.97	9%	3188.11	6%	47.16	1%
Scaevola taccada (Magoo)	4624.18	2%	183.24	4%	1346.24	1%		0%	2521.43	2%	293.76	12%	1101.49	2%	2.16	0%
Pemphis acidula (Kuredhi)	7537.57	3%	161.28	2%	3115.37	3%		0%	1529.26	1%	869.48	57%	74.16	0%		0%
Pandanus (Kiahikeyo)	7533	3%	1363.68	18%	1670.4	2%	2186.48	131%	4030.92	3%	1620.64	40%	720.36	1%	4.32	1%
Guettarda speciosa (Uni)	9965.28	4%	158.76	2%	2497.26	2%		0%	2019.95	1%	136.08	7%	342.72	1%		0%
Calophyllum inophyllum (Funa)	3481.2	1%	958.32	28%	1627.56	2%	1847.88	114%	3308.03	2%	1062.35	32%	158.76	0%	4.32	3%
Hibiscus tilaceus (Dhiggaa)	28706.3	11%	11714	41%	5272.52	5%	1266.48	24%	10728.81	7%	1778.56	17%	1608.84	3%	80.28	5%
Ochrosia Oppositfolia (Dhunburi)	30663.9	12%	1105.63	4%	2395.07	2%	2703.8	113%	17711.8	12%	1936.03	11%	3468.52	7%	397.07	11%
Tournefortia argentea (Boashi)	264.23	0%		0%	126.72	0%		0%	65.16	0%		0%	5.76	0%		0%
Mixed forest	77202	31%	49136	64%	44900.3	43%	7648.95	17%	68009.1	45%	7863.81	12%	8920.25	17%	36	0%
Unvegetated land	48851.8	19%	4274.8		24937.36	24%	1422.8		14168.9	9%	1562.18	11%	32592.95	62%	717.69	2%
Total tree cover removal			**69389.2**				**19577.2**				**19437.82**				**670.31**	
Total vegetated area	**251092**				**104027**				**150588**				**52336**			
Total clearanc area	**73664**		**73664**		**21000**		**21000**		**21000**		**21000**		**1388**		**1388**	

Figure 31: Hulhuvaarulaa Vegetation and remnant of house used by the inhabitants of the island in the past

7.3 HISTORICAL USE

Historically Hulhuvaarulaa was an inhabited islands, later it became to an agricultural island. It was not very clear why the inhabitants abandoned the island. Large part on the north side of the island has been cleared to grow agricultural crops. The 1969 aerial photographs show fairly wide roads across the island and some urban areas.

Menthandhoo has been using as an agricultural islands until very recently. Various types of chillies, Papaya and other types of trees were grown in the island. Remnants of the agricultural activities can be seen on the island.
Similarly Golhaalaa was used for agricultures until 2004. Since then no activity has been taken in the island.

Figure 32: Menthandhoo vegetation, showing land cleared and used agriculture

7.4 GROUNDWATER ASSESSMENT

Three ground water samples one sample from each island, Hulhuvaarulaa, Menthandhoo and Golhaalaa were obtained for laboratory analysis. Location of the groundwater samples are shown in Figure 21 and the results are shown in Table 10.

Considering the pH levels of both the samples, they could be considered slightly basic given all the samples had a pH level above 7. Ground water sample obtained from Hulhuvaarulaa had a pH of 7.20 while in Menthandhoo and Golhaalaa pH was found to be 7.30 and 7.22 respectively. Hence all are within the range acceptable for drinking water as far as pH for drinking water is concerned.

Three samples meet recommended value of 50 mg-NO_3/L for level of nitrates in drinking water that has been set to protect bottle-fed infants less than 3 months of age.

Three samples had total dissolved solids (TDS) levels less than 1200 mg/l is considered palatable. TDS levels in groundwater sample from Hulhuvaarulaa were 304 while in Menthandhoo and Golhaalaa was 368 and 347 mg/l respectively. No health-based guideline value for TDS has been proposed.

Salinity levels in groundwater samples from the three islands are very low; Hulhuvaarulaa 0.29, Menthandhoo and Golhaalaa 0.36 and 0.34 respectively and it is much lower than US Environmental

Protection Agency standard of 500 ppm recommended for drinking water. Original water test results are provided in Annex 6.

Ground water from the island will not be extracted to use for any purpose. The project will develop an integrated water resource management facility which will entirely depend on rainwater harvesting and collection of condensate water from greenhouses .

Table 10: Results of ground water samples analysed at the MWSC laboratory

Parameter	Hulhuvaarulaa	Menthandhoo	Golhaalaa
Physical appearance	Clear	Clear	Clear
Temperature ^{o}C	21.7	21.4	22.7
Nitrite (mg/l)	0.014	0.011	0.018
pH	7.20	7.30	7.22
Salinity (‰)	0.29	0.36	0.34
Sulphate (mg/l)	<10 (LoQ 10mg/L)	18	<10 (LoQ 10mg/L)
Nitrogen Ammonia	0.38	0.24	0.34
Phosphate	1.25	<0.05 (LoQ 0.05mg/L)	0.07
Total dissolved solids (mg/L)	304	368	347

7.5 SOIL CHARACTERISTICS

Soil characteristics of three islands Hulhuvaarulaa, Menthandhoo and Golhaalaa were visually observed and analysed the soil profile of the area, a hole (2 x 2ft) was dug (See Figure 21 : survey location map) on the islands. A soil profile was not taken from Dhoonirehaa as the whole island is formed of coral rubble and not much development will take place on this island. The soil conditions of the three were similar to soil conditions of many islands across the Maldives, consisting considerable quantities of un-weathered corals as parent materials, coral rocks and sand.

Coral debris is the main constituent of the island's soil with varying amounts of plant material incorporated depending on the location and maturity of the island. Dark soil developed in the three islands is at different level. Soil profile in Hulhuvaarulaa Island was better developed than Golhaalaa and Menthandhoo, while soil is least developed in Golhaalaa (Figure 33). In three islands the top soil layer contains some degree of greyish to chocolate black fine to coarse sand mixed with plant roots. The water table is at depth of 0.9m in Golhaalaa, 1.1m in Menthandhoo and 1.3m depth in Hulhuvaarulaa.

Engineering properties particularly Standard Penetration Test (SPT) N-values (No. of blows- value) was obtained from average of SPT N-values obtained for similar type of soil from similar depth in number of islands.

A more generic engineering properties for coral rock and sand was obtained from (Riyaz and Park, 2010) in Table 11.

Table 11: Generic engineering properties for coral rock and sand adopted from (Riyaz and Park 2010)

Layer	SPT N value	Bulk density (t/m^3)	Elastic modulus (t/m^2)	Cohesion (kPa)	Friction angle (degree)
Tightly-cemented cap rock	65~200	1.9	60,000	50	40
Weakly-cemented mixtures of coral sand and gravel	-	1.8	20,000	0	38
Coral sand and gravel with coral blocks	24~117	1.8	60,000	50	40
Reefal limestone	>200	1.9	60,000	50	40

 Hulhuvaarulaa soil profile	40cm thick blackish brown, fine-medium coral sand rich in silt and plant root material, rich in humus content average SPT N-Values 3-8 40 cm thick grey medium dense, fine- medium coral sand, with silt and plan root material Average SPT N-Value 5-17 50cm thick light grey- creamy white medium to coarse coral sand, less silt and plant material, more moisture content, partly wet, minor rubble particles Average SPT N-values 9-17 Water table at 1.3m
 Menthandhoo soil profile	30 cm thick dark Chocolate colour very fine- medium coral sand with rich silt and tree root and humus content average SPT N-Values 3-5 37 cm thick, light grey-creamy white fine-coarse friable uncemented coral sand, less silt and minor amount of plant material, more moisture content, decrease greyness and increase coarse sand content downwards, minor rubble particles Average SPT N-values 5-15. 33 cm thick Creamy white medium to fine friable and less cohesive coral sand, less silt, increase in coral pebbles, moisture content and wetness downwards, average SPT N-values 9-17. Water table at 1.1m
 Golhalaa soil profile	30cm thick greyish brown, fine-medium coral sand rich in silt and coconut root material, dry and poor in humus content average SPT N-Values 3-5 60cm thick, light brownish-light greyish- creamy white fine-medium loose uncemented coral sand, less silt and minor amount of plant material, more moisture content, decrease greyness and increase coarse sand content downwards, Average SPT N-values 5-15. Water table at 0.9m

Figure 33: Soil structure of Hulhuvaarulaa, Menthandhoo and Golhaalaa islands

7.6 ISLAND MORPHOLOGY AND BEACH DYNAMICS

The three islands, Dhoonirehaa, Golhaalaa and Menthandhoo seem to be initiated and developed as Shingle (rubble cays) cays that usually develop on strong energy environment. Shingle cay initiation and development of rubble ridge on the reef flat close to the reef flat inner edge created clam areas on the lee (western) side of the ridge which allowed deposition of more fine and smaller sediment particles that settle on low energy conditions. As the islands grew bigger and older rubble cay developed in the early stage was eroded away leaving beach rock formed of strongly cemented coral rubble and boulder conglomerate. , The existence of extensive beachrock outcrop on the eastern edge of the three islands is a geologically significant evidence for the formation and development of the three islands.

Soil composition in Hulhuvaarulaa indicates that the island was formed and developed in a relative calmer environment. Presence of the island on the lee of Menthandhoo and Golhaalaa provided sheltering and calm environmental condition for initiation, development and deposition of fine coral sand. Presence of large amount of beachrock on the western side of Hulhuvaarulaa indicates that the island went through large scale erosion on the western side. Comparison of aerial photographs of 1969 and the recent satellite images indicate that the southern end of the island has been developed in a later stage or it has been an existing smaller cay joined with Hulhuvaarulaa. Presence of beachrock on the western side of Hulhuvaarulaa indicates that the influence of south western monsoon influence on sediment removal is more than the NE monsoon (Figure 34-Figure 37). Few series of shore parallel beach rocks are exposed on the western side of Hulhuvaarulaa. The shore perpendicular bachrocks series on the southern end of the island indicate the position of the beach of the old island in the past. From the presence of beachrock it could be concluded that the island beach was wider and longer on the southern and western side than present beach positions.

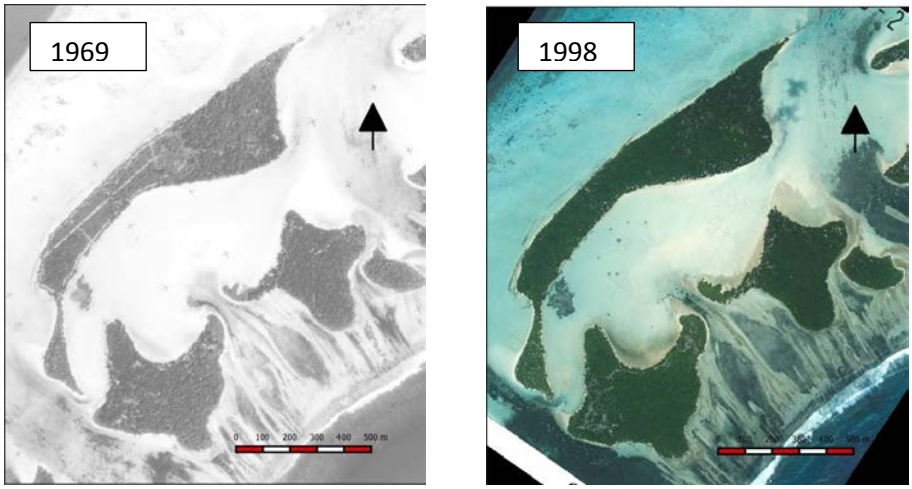
Figure 34 Beachrock on the western side of Hulhuvaarulaa

Figure 35: Beachrock on the eastern side of Menthandhoo

Figure 36 Beachrock on the eastern side of Gohaalaa

Figure 37: Beachrock on the eastern side of Dhoonirehaa,

Long term changes of the islands have been studied by using combination of low level aerial photography taken in 1969 and 1998 and satellite images and Google Earth images Figure 38. The study shows that 1969 eastern shoreline of Dhoonirehaa Golhaalaa and Menthandhoo retreated and eroded related to 1998 and 2012 shoreline. While the north, northwest and western shoreline of the three islands accreted in relation to 1969 aerial photograph. In Hulhuvaarulaa most of the shoreline changes were observed on the southern and western end of the island. Growth of the bend on the southern end of the island in relation to 1996 was seen in 1998 aerial photograph while erosion and shoreline retreat was observed in 2012satellite images. From the four island most remarkable change was observed in Dhoonirehaa the island has shifted north westerly direction and the gap between Menthandhoo and Dhoonirehaa are getting progressively narrower. Figure 39 shows the long term change in island dynamics mainly the change in the vegetation line and Figure 40 shows the seasonal short term change in beach dynamics of the four islands.



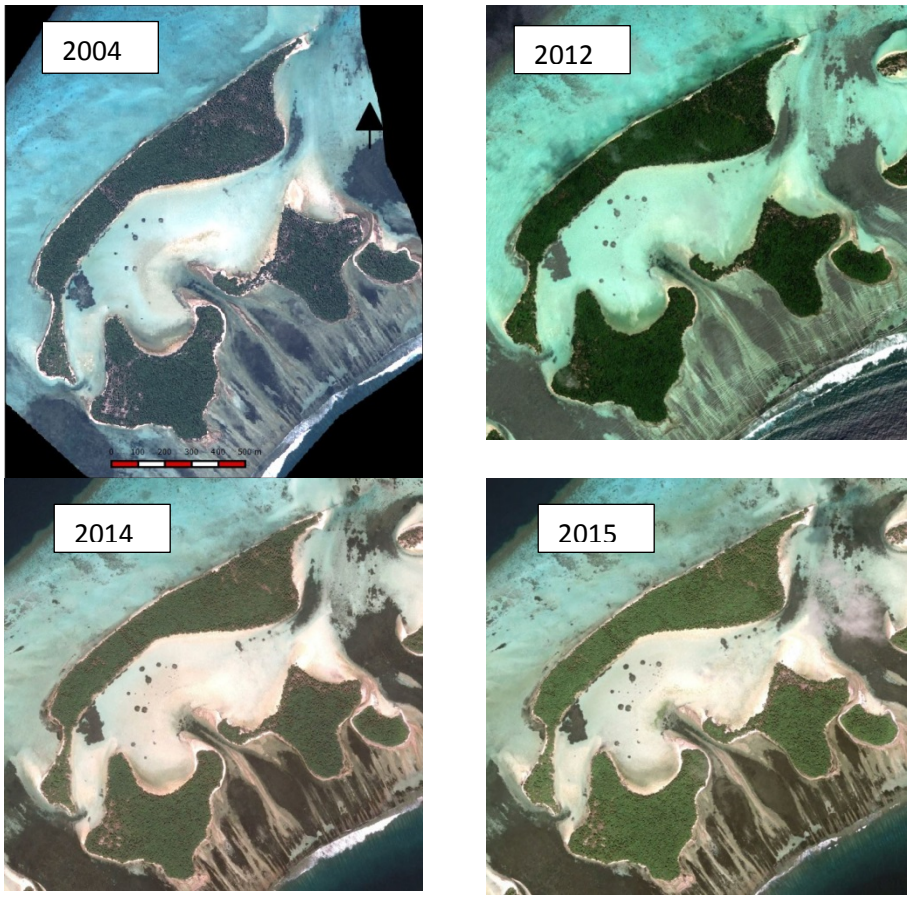


Figure 38: sequence of aerial photographs and satellite images used for the assessment of long term changes in the island and shoreline dynamics (year top let corner, 2012-2015 satellite images are taken from Google earth®)

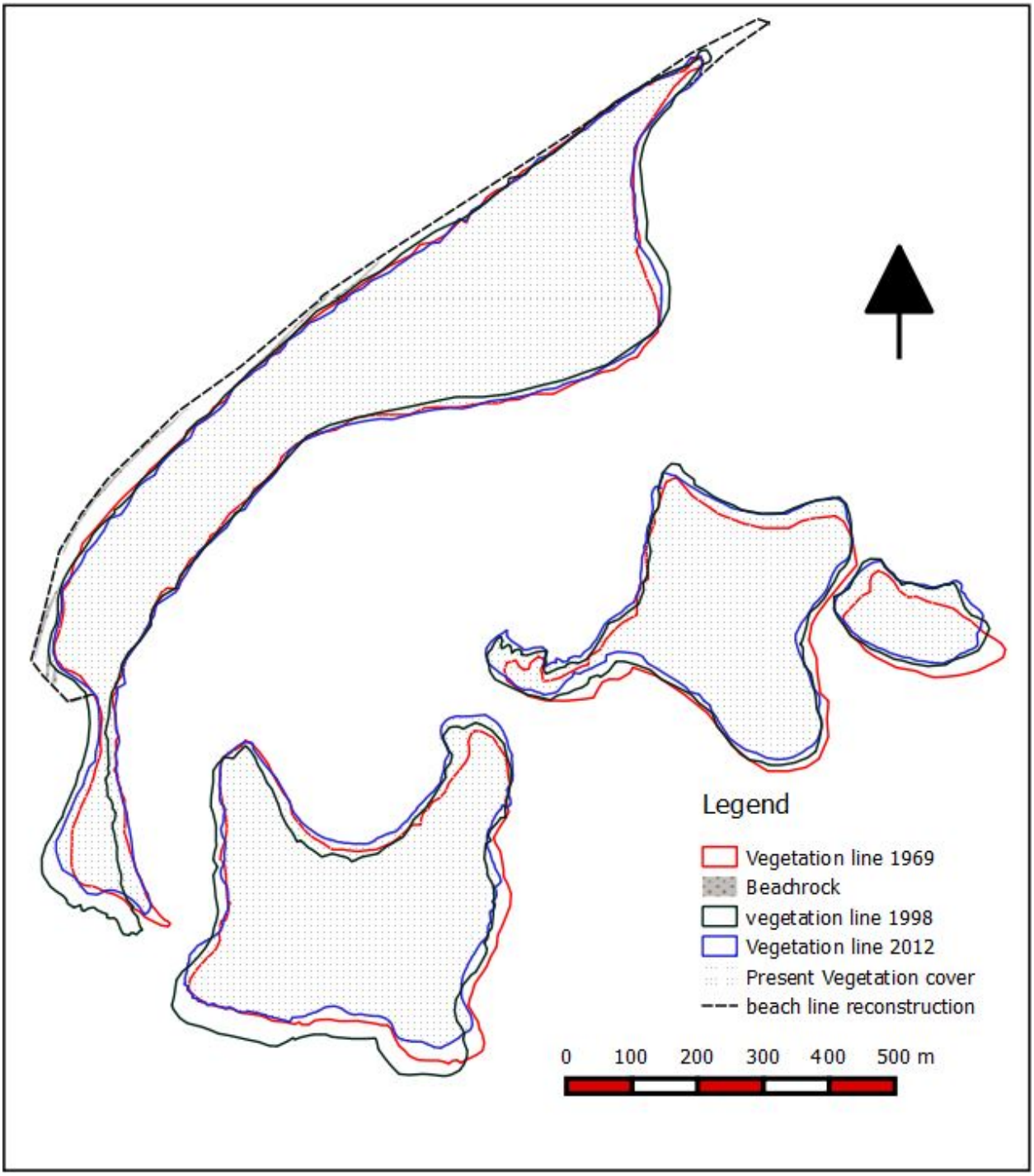


Figure 39: long term changes in island dynamics

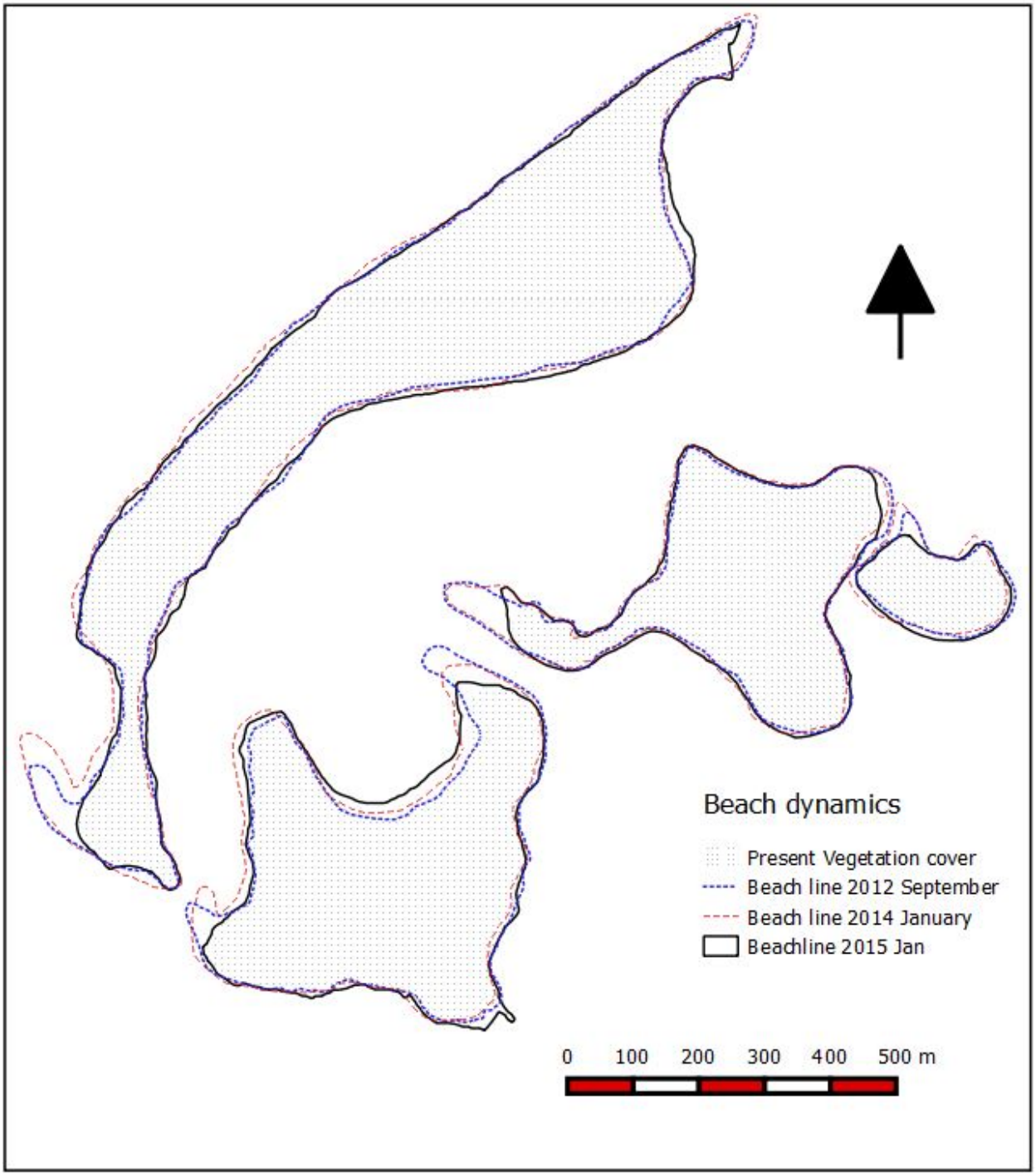


Figure 40: Short term changes in beach dynamics

7.6.1 Beach profiles

Two beach profiles are taken from the northern and southern end of Hulhuvaarulaa. A transact was taken across the sand spit on the northern end Hulhuvaarulaa. Three profiles from Menthandhoo, two profiles and one transact from Golhaalaa. Location of beach profiles are shown in Figure 21 and coordinates and bearings are given in Table 12.

Profiles and transacts are concentrated on the dynamic areas of the island eg: sand spits. Beach profile 1 from Hulhuvaarulaa northern end of the island shows a fairly wide accreting beach, while the southern shows an erosion scarp with sharp fall from vegetation ridge to the beach. The three beach profiles of Menthandhoo shows extremely sharp edge between the beach and island ridge, which is indication dominant erosion. Beach profiles 1 and 2 from Golhaalaa shows fairly wide gradually sloping beach. Gradual slope is an indication of low energy accretion areas while steep sloping beach are found on high energy erosional areas. Beach profiles of the three islands are shown in Figure 41.

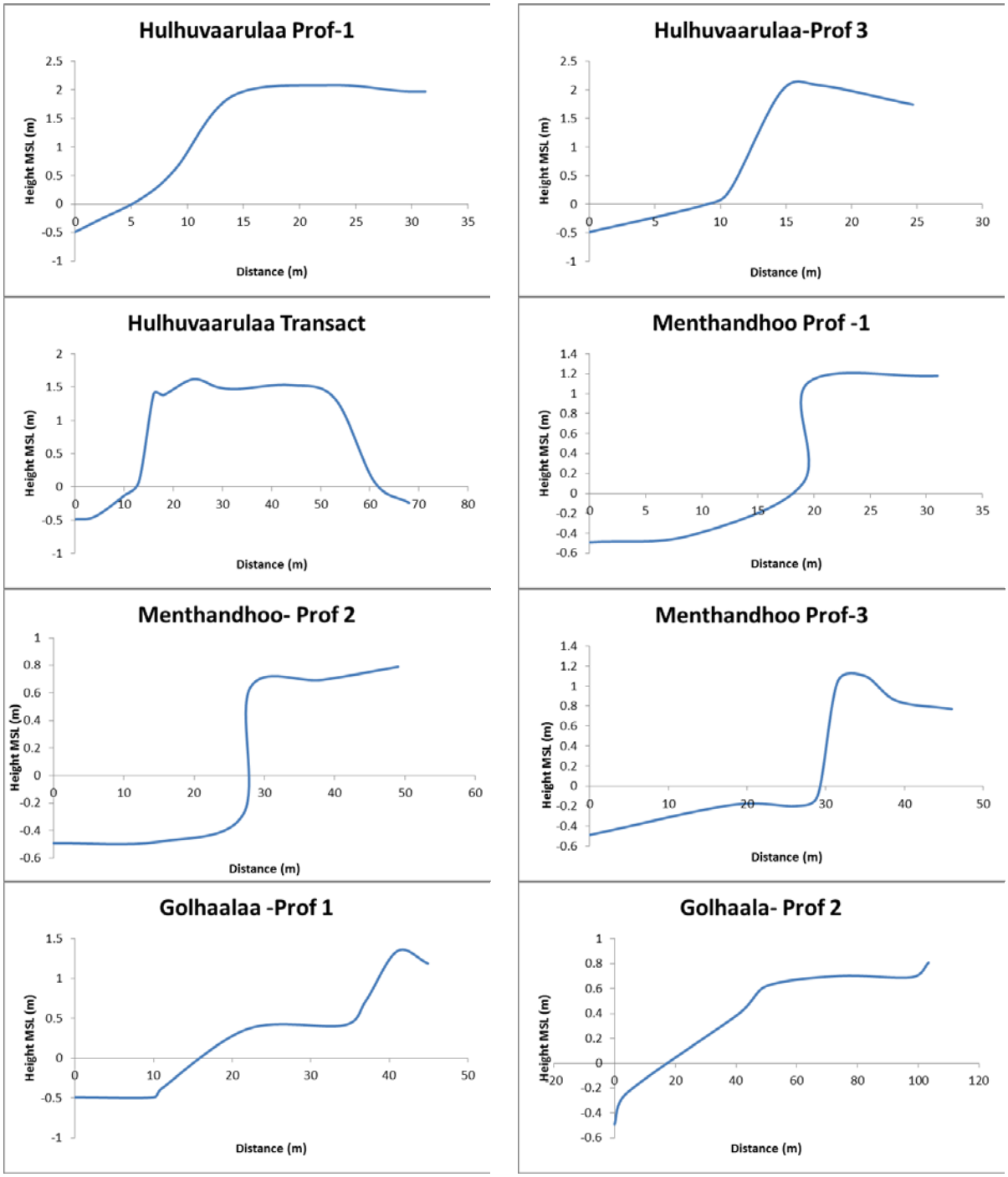


Figure 41: Beach profiles and transacts, Hulhuvaarulaa, Menthandhoo and Golhaalaa

Table 12: Geographic coordinates and bearing directions of beach profiles

Profile name	XY coordinates decimal degrees)	Profile bearing Deg
Hulhuvaarulaa Prof-1	0.331796,73.491088.	1152
Hulhuvaarulaa Prof-2	0.321498,73.482415	270
Hulhuvaarulaa transact	0.331796,73.491088.	42-242
Menthandhoo Prof -1	0.326297,73.490825	304
Menthandhoo Prof -2	0.326297,73.490825	37
Menthandhoo Prof -3	0.325727, 73.493215	99
Golhaalaa -Prof 1	0.319783, 73.484252	275
Golhaalaa -Prof 2	0.323256, 73.487749	300

7.6.2 Status of Fauna

The location seems to be an area of significant importance for shorebirds and seabirds with a large number of bird species observed during the field visit. Some of the sea-faring birds recorded on site include the Dhandifulhu Dhooni (*Phaethon lebturus*), Kiru Dhooni (*Sterna sumatrana*), Findhana (*Actitis hypoleucos*), Valla (*Sterna dougalli*) and Maakanaa (*Ardea cinerea*). Some resident birds observed on the island include the Koveli (*Eudynamys scolopaceus*) and Kaalhu (*Corvus Linnaeus*), *Areneria melanocephala* (black turnstone), *Tringa hypoleucos* (common sandpiper) and *Numenius arquata* (eastern curlew) were observed.

Four species of reptiles; the mourning gecko (Lapidodactylus lugubris) and the garden lizard (*Calotes versicolor*) blind snake (*Ramphotyphlos braminus*), the Common house gecko (*Hemidactylus sp*.) were also observed. In general several terrestrial and intertidal crabs, butterflies, moths, beetles, spiders and scorpion were observed on the Island.

The only terrestrial mammals to be recorded on the island are the Rat (*Rattus sp*.) and Fruit bats (*Pteropus giganteus ariel*). Rats are common and abundant and seem to be infested by rats throughout the islands it can be easily managed once the island comes into operation. Bats were rarely seen, mainly due to the lack of large fruit bearing trees.

Due to the short amount of time that is usually spent during field visits, the number and type of species recorded may not be completely accurate to study avian fauna of the island. In order to complete a detailed study of birds found on this island, it will require several months on-site observation.

7.6.3 Pests

Among animal pests, rats (*Rattus norvegicus*) were the most notable species recorded on the island. Rats currently feed on fallen coconuts and other food waste (leftovers by picnic goers) but are expected to be controlled once the island comes into full operation and appropriate control measures are put in place by the management.

Although fruit bats (*Pteropus giganteus ariel*) are not reflected as pests in the general environment, it is considered as a pest species in most of the islands.

The only significant floral insect pests, observed in the general environment of the island was the Rhinocerous beetle (*Oryctes rhinoceros*) on the coconut palms and the Leaf miner (Unidentified species) observed on some Magoo plants (*Scaevola taccada*) on the island.

The exact parent species of the leaf miner is often unknown unless an extensive classification process is carried out. Leaf miners are the larva of an insect that lives and eats the leaf tissue of the plants. The larva

could be from one or more of the moth/butterfly (*Lepidoptera* family) or fly (Diptera) species found on the island.

Mosquito (*Culicoidea* family, genus Unknown) population on the islands are quite high due to the large amounts of green waste accumulated on the island, but it is expected to be controlled once the development commence and starts to keep the general environment of the island clean.

8 MARINE ENVIRONMENT

8.1 MARINE ENVIRONMENTAL SETTING

The characteristics of reefs and coral islands of the Maldives vary considerably from north to south. The atolls to the north are broad banks discontinuously fringed by reefs with small coral islands and with numerous patch reefs and faros in the lagoon. To the south the depth of atoll lagoon increases, faros and patch reefs are rare in the lagoon, the continuity of the atoll rim is greater and a large proportion of the perimeter of the atolls is occupied by islands (Woodroffe, 1992).The islands have shallow reef flats on their seaward side, some with shingle ramparts at the seaward limit of the reef flat. The islands and the shingle ramparts owe their origin to the deposition of shingle or coral debris during storms. A number of islands can be found on a single reef. These islands may be separated by shallow passages that run across the reef flat. The width of some of these passages could be less 100m while some passages are over few hundred meters wide.

The reef of Gadhdhoo consisting of the islands earmarked for development in this project (Hulhuvaarulaa, Golhaalaa, Menthandhoo and Dhoonirehaa) are part of a rim reef located at the South east corner of Huvadhu atoll. The reef stretches in a SW to NE direction and consists of 10 islands altogether. The reef has an area of 15 sq km and the total area of the 10 islands on the reef is just over 2 sq km. The islands display strong geomorphic zones induced by strong wave action reaching the reef from the SE. The reef is about 12 km in length and 1.5km wide on average.

8.2 CORAL REEF HABITATS

Reef habitats were delineated based on satellite data and benthic assessments. Habitat were mapped using satellite imagery combined with extensive field assessments and are shown in Figure 42 (Fig showing ground truthing points for verification of satellite data). General reef geomorphology and habitats was determined from satellite imagery and field surveys. Geomorphological zonation of the study area was mapped and their functions are described.

Figure 42: Sampling points for marine habitats

8.3 LARGE SCALE HABITAT CHARACTERISTICS OF GADHDHOO REEF

Parts of Gadhdhoo Reef encompassing the 4 islands of Hulhuvaarulaa, Golhaalaa, Menthandhoo and Dhoonirehaa can be characterized by distinct bio geomorphic zones (Figure 43-Figure 45).

8.3.1 The Fore reef zone

The fore reef zone on the eastern side of the reef system could not be reached due heavy surf and wave action. The reef slope on this side is characterized by strong spur and groove formations indicating the nature of hydrodynamic forces on the reef (See Figure 43 on spur and groove formations).

Figure 43: Spur and groove formations on the seaward slope facing the south eastern swells off Golhaalaa.

8.3.2 The back reef rubble zone

The back reef rubble zone is scattered with coral boulders and rubble resulting from the erosion and disintegration of exposed beach rocks. Interestingly there were very little fresh deposits of coral rubble anywhere on the seaward side of the islands. This is the reef zone where the highest energy is received at the eastern side of the reef. The reef crest was hardened and cemented and devoid of corals. Both the crest and rubble zone consisted mostly of dead coral and rubble of varying sizes which were scattered all over. Substrate sizes varied from small mobile coral rubble to large boulders heavily covered with turf algae. Few live corals were observed. *Acroporiids, pocilloporiids* and *poritiids* were noted.

Closer to the surf zone live massive corals grew on hard bottom. These were typical massive corals shaped by strong wave action and sealevels. The sides of such corals were partially live as in micro atolls. Again the surf zone consisted of rubble and boulders all dead. Very little live coral cover was observed.

The dead coral substrates of the surf zone were interspersed with under cuttings (typically formed by wave action and exposure). The area is best characterized as a boulder zone and is about 200-300 meters wide.

It was noted that all substrate here at the surf/crest zone were uniformly covered with by turf algae and encrusting calcareous algae and encrusting corals. Some filamentous algae also occurred.

Figure 44: Back reef rubble zone

8.3.3 Back reef seagrass beds

The back reef areas were also dominated by extensive seagrass beds of varying thickness with very few live coral patches. Seagrass was noted to be a dominant habitat type on all areas of the reef especially on the back reef areas.

Figure 45: exposed seagrass on backreef areas

8.3.4 Rubble dominated beaches on the ocean ward side

The beaches on the ocean ward side of the islands of Golhaalaa, Menthandhoo and Dhoonirehaa were all distinctly line with complex beach rock formations. Most of the structures were exposed at low tide and represents fossilized coral structures consisting embedded coral rubble of varying sizes. These beach structures were being eroded away and the rubble generated by the process was observed on the beaches and near shore environments.

Figure 46: Ocean ward side beach covered with fossilized coral rubble and boulder conglomerate

8.3.5 The atoll lagoon ward side shallow lagoons

The lagoon side of the reef is mainly a shallow sandy lagoon with coral patches and seagrass patches. The Acropora patches scattered within the lagoon were in bad shape and dying off mostly but were in growth position. The fact that slender branching Acropora sp (possibly *A. Formosa*) were found dead and in growth position leads us to believe that they are recently dead corals. It is common to see such burst of Acropora growth on shallow lagoons facing the atoll lagoon and such habitat are seen to die off and growth within short time frames of over a couple of years. Large monospcific patches of the blue coral Helipora were also observed in the shallow lagoons. Helipora was also observed growing within seagrass patches.

Figure 47: Two major types of coral habitats found on the lagoon ward side of Hulhuvaarulaa; large strands of Acropora Formosa and patches of Helipora were observed.

8.4 SEA GRASS HABITATS

Sea grass was found on all zones of the reef at the project site. In fact it was a major habitat feature of the reef. On the west side of the island are sub tidal rubble and sandy areas were dominated by seagrass beds. Seagrass beds occur on both sides of the island and represent the major ecological features of the shallow lagoon around the islands.

Sea grass beds represent one of the most productive and important habitats in the nearshore areas on coral reefs. Sea grass communities are found in lagoons, and shallow open reef flats off several islands in the Maldives, especially near inhabited islands. Sea grass meadows are habitat for large populations of invertebrates and fishes and provide the rich nursery and feeding ground in several reef areas.

Sea grasses are the only flowering plants that live their entire lives in water completely and are obligate seawater organism. Five species are known to occur in Maldives. Turtle grass (*Thalassia hemprichii*) is the best known, with its large, ribbon-like leaves that are 4-12 mm wide and 10-35 cm long. Two to five leaves per shoot grow from stout rhizomes that may be found as deep as 25 cm in the sediment. Turtle grass is the major species in the extensive meadows of in several coastal area mostly in central and southern parts of Maldives. Similar to turtle grass in appearance (*Thallasodendron ciliatum*) are also like thin ribbons, typically 5-15 mm wide and 10-20 cm long, 4 to 10 leaves per shoot grow from stout rhizomes that may be found as deep as 20 cm in the sediment. Manatee grass (*Syringodium isoetifoleum*) is commonly found in mixed sea grass beds or in small, dense monospecific patches. Its leaves are string-like: round in cross-section, about 1 mm in diameter and up to 50 cm long. The rhizomes are less robust than those of turtle grass and seldom penetrate as deep into the sediment.

8.5 ECOLOGY

Sea grasses require sediment of sufficient depth to allow roots to anchor the plants. A variety of sediments, from fine mud to coarse sands, support their growth. Shoal grass can colonize thin sediments turtle grass requires several centimeters of sediment depth to colonize and may achieve lush growth in sandy lagoons. Once sea grasses are established, they greatly influence local sedimentation. Deposition of fine inorganic and organic particles is facilitate by the baffling effect of the sea grass blades, the entrapment of waterborne particles in epiphytic growth on the sea grass, the production of particles within the grass beds, and the binding and stabilizing of the substrate by the root and rhizome systems.

Like terrestrial grasslands, sea grass meadows support a diverse assemblage of other organisms. Macroalgae live among the sea grasses, and both may have epiphytes attached to them. Epibenthic organisms find shelter as well as food within the meadow. Infaunal organisms live hidden within sediments stabilize the sea grass roots and rhizomes. Grazers and predators move through the community harvesting these resources.

8.6 SEAGRASS COMMUNITIES

The invertebrate fauna is exceedingly rich in sea grass communities. Larger epibenthic organisms such as gastropods, sea star), sea urchins, sea cucumbers, shrimps and lobster are example of epibenthic community. A few coral sp (e.g., *pocillopora sp*, *Porites spp*) and sponges can be found. Infauna includes a variety of clams and annelid worms. A multitude of small crustaceans lives on or in the epiphytes and sediments.

Sea grass meadows are inhabited or visited by a diverse and abundant fish fauna. Resident fishes are typically small, cryptic, and of little commercial value. Seasonal residents spend their juvenile, subadult, or spawning season feeding in the grass beds. Commercially and recreationally important fish (*Serranidae*), snappers (*Lutjanidae*) use sea grass meadows as nursery grounds. Coral reefs near sea grass beds shelter animals like snappers and lobster that feed in the meadows at night.

Some higher vertebrates can also be found in sea grass meadows. Turtle grass was named for its appeal to green sea turtles (*Chelonia mydas*). Several species and a variety of sea birds also use sea grass beds as feeding grounds.

8.7 NUTRIENT FLOW

Sea grasses are extremely efficient at capturing and utilizing nutrients, a major factor in their ability to maintain high productivity in relatively low nutrient environments. They are apparently capable of absorbing nutrients through either their leaves or their roots. *Zostera*, a sea grass common in somewhat higher latitudes, can take up ammonia and phosphate from the sediments and transport the nutrients to the leaves, where they can be pumped into the surrounding water. If turtle grass has the same capability, it should be of tremendous benefit to epiphytic algae on the sea grass blades, particularly in the nutrient-poor waters associated with coral reefs. Sediment depth may play an important role in nutrient dynamics in the sea grass bed, for deeper sediments allow more extensive development of roots and rhizomes. Furthermore, extensive root systems may be needed to sustain growth in sediments that contain few nutrients.

Figure 48: Sea grass from different areas of the reef around the islands. Coral were also found within seagrass patches most commonly branching *Porites* and *Helipora* sp.

8.8 THE CENTRAL TIDAL FLATS

The formation of the islands of Hulhuvaarulaa Golhaalaa, Menthandhoo and Dhoonirehaa created a shallow sandy bay in the central region as seen from the Figure 20. The area is more like a mud to fine sand flat close to the beach area on some of the islands but with clear fine sand towards the middle of the bay. The bay gets exposed daily with tidal fluctuations and the soft sediments make it a rich feeding ground for bottom feeders most importantly sting rays. Distinctive pits dug by rays for their feeding were evident close to the beach areas around the bay Figure 49.

Figure 49: The sand / tidal flats were important feeding habitats for many species of birds and fish too. It is also a nursery for species of reef sharks and other reef life. Turtles were seen feeding on the seagrass in the bay area.

8.9 CORAL REEF ASSESSMENT METHODS

8.9.1 Manta tow surveys:

A broad scale survey methodology known as manta tow survey was used to assess the general status of the reef topography and various reef habitats along a large section of the reef slope. Manta tow technique is often used to assess broad changes in the benthic community of coral reefs where the unit of interest is often an entire reef or large portion thereof. It enables rapid visual assessment of large areas of reef habitat within a short time. Information from the manta tow reef assessment has been used for the selected sites for more detailed reef assessments that are representative of the various habitats have been used (English et al., 1997).

For this study an observer was towed behind a slow moving boat over the area - in this case over the edge of the reef slope at 1-3 meter depth for 15 min with a GoPro camera capturing high definition video of the reef for about 800 meters (see Figure 42 for Manta tow start and end points). The observation of coral cover was determined by detailed video analysis.

8.9.2 Quadrat surveys:

Photo quadrat survey was done on the eastern side of Hulhuvaarulaa (see Figure 42 for quadrat survey site location) on reef slope. A 1m x 1m , 1.0 m2 quadrat made from ½" PVC pipes were randomly placed on the reef slope about 2-3 m Figure 50 to show the quadrat). In some cases quadrat needs to be moved to ensure it sits evenly on the reef. A photo image from above, looking flat on the quadrat, was taken for further analysis. Twenty quadrats were captured to obtain replicate samples. Quadrat images were subsequently analyzed using Coral Point Count with Excel Extension (CPCe: http://cnso.nova.edu/cpce/) software in which benthic cover was estimated. Five different categories were used (live coral, dead coral, rock, rubble and sand).

8.9.3 Fish Census:

At the same site where quadrat samples were taken, fish census was done. A ten minute swim along the reef slope (see Figure 42 for location of fish census) captured high quality video which was later analyzed noting all fish in the visual field.

8.9.4 Manta Surveys Results:

Observations and estimations of the manta tow assessments along the eastern reef slope estimated that the reef had over 50% live coral cover. Dead coral substrate provided ample settling areas for new coral recruits.

Among live corals observed at the area, dominant species were *Acroporiids*. Live corals genera observed at the site include, *Porites, Pavona, Psammacora, Favites, Echinopora, Favia* and *Pocillopora*. Large massive colonies of *Porites* were found on the reef slope indicating the long term growth and health of the reef.

Figure 50: Showing 1x1m quadrat on reef

8.9.5 Substrate cover at the sites surveyed

Site one: Reef flat / surf zone

Calcareous algae were the dominant life form colonizing the bare substratum at reef crest on the eastern side followed by colonial Ascidians. Live coral cover at this area was very low at about 1-2%. This is due to the high wave energy from the swells breaking off the surf zone. All life forms of corals at this zone were adapted to high energy. Coral diversity at the area was very low, among the live corals observed *Porites sp* (massive life forms) and *Acropora digitate* forms were observed. *Acroporiids* common to high energy areas were found. The low coral cover observed may also be due to the lush growth of turf algae in the area, which is competing for substrate and seen overgrowing on the coral colonies (Figure 51). *Halimeda* and other calcareous algae are common in the surf zone.

Diversity at surf zone was very low, probably due limitations relating to high energy and harsh conditions and also due to competition with turf algae and colonial Ascidians. Altogether six genera of corals were observed on underwater video assessments. Among the genera *Porites* and *Acropora* were dominant, accentuated by encrusting and digitate life forms of *Acropora*. Other live coral genera include mainly encrusting forms like *Psammacora, Goniastrea* and *Montipora* species. Live coral genera observed include *Porites, Pocillopora, Montipora, Goniastrea, Acropora, Psammacora*.

Figure 51: Colonial Ascidians, calcareous algae and few coral colonies many encrusting forms dominated the surf zone

Figure 52: Massive and encrusting coral life forms surviving at the surf zone

Site Two: Reef flat and slope on the west side of Hulhuvaarulaa

Based on the analysis of bottom habitats using photo quadrats live coral cover was 40% on the reef slope. Dead coral rubble was low compared to dead coral substrate indicating good potential for coral settlement, growth and survival (Figure 53).

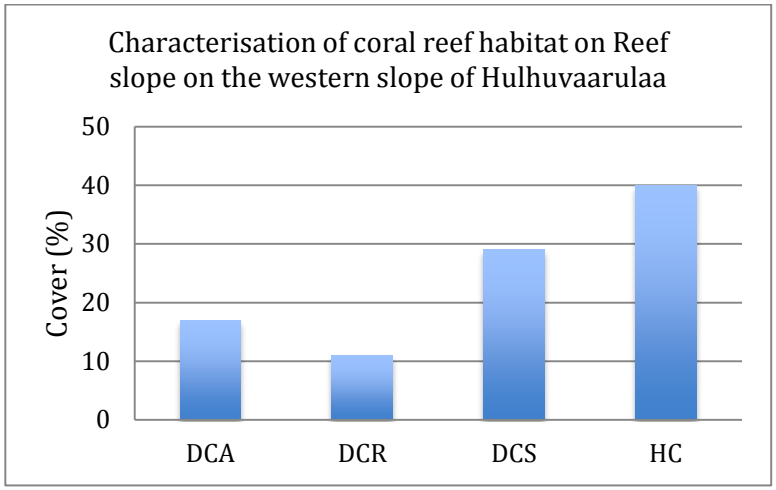


Figure 53: Substrate cover on reef slope on the western lagoon slope of Hulhuvaarulaa based on the analysis of 20 x 1 m^2 quadrats. (DCA = Dead Coral Algae, DCR = dead coral rubble, DCS = Dead coral substrate, HC = Hard coral).

Coral genera observed at the side included *Porites Acropora and Goniapora, Echinopora, Pavona, Laprastrea, Diploalstrea, Lobophyllia* were dominant.

8.9.6 Fish Diversity

More than 40 species of fish comprising 8 families including *Acanthuridae, Labridae, Chaetodontidae, Scaridae, Lutjanidae and Pomcanthidae* were observed. Abundance of fish observed during the swim is described here arbitrarily as rare, common and very common (Table 13).

The highest number of species were observed in family *Acanthuridae* followed *by Pomacentridae* and *Labridae*. It should be noted that the species observed composition may be biased because this was done in a snorkel swim. It is likely that the deeper and small cryptic species may be under-sampled. Nevertheless the fish composition and abundance information represent a useful summary of the fish fauna at Hulhuvaarulaa western reef at the time of this observation.

Table 13: Observation of fish on Transects at Site 2 at western lagoon slope of Hulhuvaarulaa. Codes: R = Rare, C = Common, VC = Very Common,

Transec # 1

Family	Species	Abundance
Acanthuridae	*Acanthurus leucosternon*	VC
Acanthuridae	*Ctenochaetus binotatus*	C
Acanthuridae	*Acanthurus nigricans*	R
Acanthuridae	*Ctenochaetus striatus*	VC
Acanthuridae	*Ctenochaetus strigosus*	R
Chaetodontidae	*Chaetodon auriga*	R

Chaetodontidae	*Chaetodon triangulum*	R
Ephippidae	*Platax orbicularis*	C
Pomacanthidae	*Pomacanthus imperator*	R
Pomacanthidae	*Pygoplites diacanthus*	R
Pomacentridae	*Chromis viridis*	C
Pomacentridae	*Dascyllus aruanus*	C
Pomacentridae		C
Labridae	*Labroides dimidiatus*	C
Labridae	*Helchoeres hortulanus*	R
Labridae	*Halichoeres hortulanus*	R
Labridae	*Halichoeres vrolikii*	R
Labridae	*Chelinus digramma*	R
Labridae	*Labrid spp*	C
Scaridae	*Cetoscarus bicolor*	R
Scaridae	*Scarus frenatus*	C
Scaridae	*Scarus spp*	C
Scaridae	*Scarus soriddus*	C
Scaridae	*Scarus niger*	R

Transect #2

Family	Species	Abundance
Acanthuridae	*Zebrasoma veliferum*	R
Acanthuridae	*Acanthurus leucosternon*	VC
Acanthuridae	*Naso elagans*	R
Acanthuridae	*Ctenochaetus binotatus*	R
Acanthuridae	*Ctenochaetus striatus*	VC
Chaetodontidae	*Chaetodon auriga*	R
Pomacentridae	*Abudefduf sexatilis*	VC
Pomacentridae	*Chromis dimidiata*	C
Pomacentridae	*Chromis viridis*	VC
Pomacentridae	*Chromis ternatensis*	VC
Lutjanidae	*Lutjanus biguttatus*	R
Labridae	*Labrids*	C
Nemipteridae	*Scolopsis bilineatus*	R
Scaridae	*Cetoscarus bicolor (male + females)*	C
Scaridae	*Scarus frenatus*	R
Scaridae	*Scarus gibbus (males + females)*	R
Scaridae	*Scarus caudaofasciatus*	R
Scaridae	*Scarus sordidus*	C
Serranidae	*Anthias spp.*	R

8.10 MARINE WATER QUALITY ASSESSMENT

For determining existing lagoon water quality, water sample was collected from two locations on the lagoon and analysed. The first sample was collected from the western side Hulhuvaarulaa lagoon and the second one from the eastern side Dhoonirehaa where the proposed seawater intake pipe will be laid. Sampling locations are shown in Figure 21. The data can act as a reference during the project monitoring period. The data for the island lagoon is given in Table 14.

Table 14: Marine water quality analysis laboratory results

Parameter	Lagoon sample west	Lagoon sample east
Physical appearance	Clear	Clear
Temperature	22.6	22.5
pH	8.19	7.22
Sulphate	2900	3000
Salinity (‰)	34.80	35.31
Phosphate	0.07	0.07
Total dissolved solids (mg/L)	26406	26800

9 SOCIO-ECONOMIC ENVIRONMENT

9.1 INTRODUCTION

As part of outlining general socio-economic environmental condition for the proposed agriculture development project on the four islands Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa in Gdh. Atoll, socio-economic conditions of the Atoll in general and more specifically that of Gdh Gadhoo has been looked into since the project impact is expected to be highest on this island considering its close proximity to the project site as well as it being the Atoll hub for all commercial and administrative activities.

9.2 POPULATION

The total registered population of South Huvadhoo Atoll in 2014 was 13152, 11765 Maldivian and 1387 expatriates. The total enumerated population of the Atoll, from Maldives population and housing census of 2006 is reported as 11013 (Ministry of Planning and National Development, 2008). At present there are 7240 males and 5912 females (MPND, 2008) in the atoll represents 3.41 % of the national population. Annual population growth is 0.70/ year. After the Atoll capital Thinadhoo Gadhdhoo has the second largest population 1489 people which represent approximately 11% of the total population of the Atoll. Population migration to Male' and Thinadhoo for various purposes was considered high for the Atoll.

The household income survey 2009/2010 reports the number of households in Gadhdhoo as 344. The average household size in Gadhdhoo is 5 persons.

Expatriate population are on a growing trend throughout the island of the Maldives and the islands of Gdh are a no exception. Many foreigners are employed by the government in education and health sector in Gadhdhoo Island. Foreigners working in the private sector were reported to be small. However, field surveys revealed that there were more. It is impossible to get an exact figure of foreign population in the private sector as there is no monitoring mechanism in the island office or employment ministry. The total number of foreigners on Gadhdhoo is estimated to be close to 150.

9.2.1 Poverty

In general, the population of Gadhdhoo appears moderately well-off compared to other islands within Gaaf Dhaalu Atoll. The Maldives Vulnerability and Poverty Assessment of 2004 (VPA II) reported that 5% of the island population have an income less that MVR 15 per day and 1% have an income less than MVR 10 per day. The figure 5% population below MVR15 per day is much lower than the national average of 21% and outer atoll average of 28%. There was no observed abject poverty on the island. (UNDP, 2009). Multi-dimensional poverty index MPI for Ga and Gdh atoll is 0.0105 and the average monthly household income and expenditure is 8,833and 10,233 respectively (HIES 2009). Per capita income and expenditure for both Ga and Gdh is 1639 and 1894 respectively.

9.3 UTILITY SERVICES HELTH AND EDUCATION

According to the information form the island council 98.9% households have access to drinking water and over 97% households have access to electricity in Gdh Gadhdhoo. Private sewerage system has been established in the island and most of the household population of the island is either connected to the system or directly connect to a sea outfall. Construction work of the water and sewerage network of the island is underway.

Gadhdhoo referral health center provides 24/7 health services for the island community. The health center has capacity to undertake minor surgeries and x-rays and other services. The health center has two resident medical doctors in the island.

Lower secondary level Gdh Atoll School with a preschool is established in Gadhdhoo. Total number of students is 305 According to the Gadhdhoo council data 98% of the population is literate.

Key infrastructures in the island includes Atoll hospital, power house, island harbour, local sewerage network, atoll school, primary schools, road networks, vocational training centre, waste management site, bank branch, religious facilities, two telecom sites and public administration building. Airport development work is underway in nearby Maavaarulaa.

9.4 ECONOMY

According to Human Development Report 2014 the human development index of Ga and Gdh atoll is nationally the lowest with an HDI values of 0.594 and Gross national income per capital GNI 4589 US Dollar. Economically active population in both in Ga and Gdh is 7825 out of which 6066 are employed and 1759 are unemployed. The unemployment rate of the two atolls is 22% and the labor force participation rate is 66%. Male employment percentage in the Atoll was found to be 76 % while 58% of female were employed. Important industries for the Atoll include, wholesale and retail trade, public administration, agriculture and forestry, health and social work, construction, and community social and personal services.

Villingilli is one of the major fishing islands in the Maldives. One of the largest fish collection and processing centre of Maldives based in Kooddoo Island is located next to Villingilli. Employment in Kooddoo manufacturing factory was identified as key income source in the manufacturing sector in the atoll. Additionally, the airport facility developed on Kooddoo and Kaadedhoo Islands provides employment benefits to people of the atoll. In addition to Atoll level administrative facilities developed on Thinadhoo makes it the whole sale and retail trade service hub for the region. The Island enjoys critical economic infrastructures such as harbour, port, power house, and communication infrastructures. The presence of the Atoll hospital and atoll school seems to provide opportunities to expand trade activities targeting temporary visitors from nearby islands (UNDP, 2009).

One tourist resort and one guest house with 20 beds is operational at present and the total tourist bed capacity of Gdh Atoll is 220 which accounts for only 0.8% of the total bed capacity of the country. Three resort development projects are currently underway in the Atoll.

The main economic activity of Gadhdhoo in terms of estimated income is fishing. It is followed by employment in agriculture civil service, and wholesale and retail trade. The mainstay of Gadhdhoo economy are the basic sectors involved in the export of goods and services – fishing, manufacturing and wholesale trade. The rest of the non-basic sectors such as transport, retail trade, hotels and other small business activities are dependent on the economic functioning of the basic sectors. Hence, a lowering of income from fisheries will reverberate through the economy. For example, a decline in fishery may lead to a reduction in demand for new housing construction and transport activities (UNDP, 2009).

Despite the availability of important facilities, the local economy of Gadhdhoo Island's economy appears to be extremely narrow based and is subjected to external shocks such as market prices of fish

9.5 SOCIO-ECONOMIC BENEFITS

The primary target of the proposed agriculture development project in Gaafu Dhaalu Huhuvaarulaa, Menthandhua, Golhaalaa and Dhoonirehaa is to produce vegetable and salads crops locally for the growing tourist industry followed by the domestic market. The aim is to substitute expensive imported products with higher quality, equal to or higher than equivalent EU operations, locally grown items. The objective is to offer provision of both skilled and un-skilled employment opportunities for locals and provide an efficient distribution and sales channel for domestic farmers in the atolls whilst increasing domestic food security and climate resiliency.

Overall the proposed agriculture development project will introduce a climate proof and more resilient and sustainable method to grow vegetables and salad crops in the Maldives. The development will contribute to achieve strategic targets towards achieving food security and overall agricultural development in the Maldives and to create employment opportunities particularly for locals. The project will also generate much needed foreign currency and contribute to the economy through tax revenue and annual rent.

Most importantly the development would diversify the local economy and reduce dependency on fisheries and tourism. Indirectly development will increase revenues to entrepreneurs, and contribute to the development of trade and service facilities such as transport, logistics and cargo supply some of the benefits that the communities of the Atoll are expected to obtain as a result from the proposed agriculture development in Gdh Atoll.

10 STAKEHOLDER CONSULTATION

The EIA scoping meeting of the project was held on 27th December 2015 at the meeting room of Environmental Protection Agency, Green building During the scoping meeting held at EPA on 27th December consultation relating to the project took place and officials representing Ministry of Fisheries and Agriculture, Environmental Protection Agency, Ministry of Environment and Energy and Maldives Food and Drug Authority, and Mr. Ibrahim Falah as the representative of the proponent – HBF Pvt. Ltd were present at the meeting. Apart from the scoping meeting consultation with the following stakeholder groups were separately held.

1- Gdh. Gadhdhoo Council
2- Gdh Gadhdhoo farmers and General public
3- Ministry of Fisheries and Agriculture
4- Maldives Food and Drug Authority (Telephone communication)

10.1 METHODOLOGY.

First the introductions of everyone were made. It was followed by the introduction of the consultants and brief explanation of what the EIA is all about. Following the proposed development project was explained including the key development features. After the briefing the floor was opened for general remarks and issues they may have on any aspect of the project.

Notes were kept for the each meeting and photographic evidence was also taken. Points of concerns from the various discussions are presented below.

10.2 SCOPING MEETING -EPA

The consultant presented an over-view of the proposed agriculture development project in the four islands. The consultant gave a background and explained the sustainable and environmentally friendly nature of this project and how it is going to introduce state of the art green technologies through the activities in Hulhuvaarulaa Menthandhoo Golhaalaa and Dhoonirehaa. He also gave an introduction of the on-going operations and similar worldwide activities of the companies involved in this project as well as the existing capacities and experiences in the field particularly in Arabian Gulf and Dubai.

In response to this Gadhdhoo council member said that he welcomes the development but the area proposed for causeway is ecologically very important area and this has to be considered. EPA requested the consultant to discuss this issue further with the proponent and explore potential options to develop the project in environmentally less damaging and sustainable manner. The consultant confirmed that alternative options will be explored and proper assessment will be carried out during the field visit. Furthermore the consultant explained about the proposed integrated water management self-contained toilets and waste water system and the seawater cooling and greenhouse technology that will be adopted in this project.

MFDA noted their responsibility lie in health and safety issues of the products. MFDA's primary role is to ensure the process of production follows internationally accepted norms of HACCP (Hazard Analysis and Critical Control Points). MFDA guidelines and approval ensures that process flow design meet those standards. As such their role at this stage of the proposed project will come after the construction and before the start of operations

10.3 GADHDHOO COUNCIL

As part of the consultation process the consultant has discussed the development with Gadhoo council and the general public of Gadhdhoo closest inhabited island to the project site, during the field visit from 26th -31st January 2016. The meeting was held on 27th January attended by all the members of Gadhoo council .

In General the people of the island are very much in favour of the project and they want the practical work of the project to start as soon as possible. The island council is hoping that the island will greatly benefit from the development directly and indirectly through creation of employment opportunities during construction and operational phase of the project, increased income, improved services and flow of much needed foreign currency into the economy. They are on the opinion that the project will contribute to improvement of public facilities and infrastructure, general improvement of social conditions and service industry activities, in addition to the increased agriculture and economic infrastructure.

The main concern of the council was that during the EIA scoping meeting held at EPA it was discussed that a causeway will be constructed between Menthandhoo and Hulhuvaarulaa to establish a road network between the islands. The island council is not in favour of this for two reasons:

- The semi enclosed area between the four island is ecologically very significant area as it provides habitat for many juvenile fish, and rays
- The causeway if established will block the passage and travel rout to the remain island in the reef system
- Work is underway to develop Maavaarulaa airport, once it is operational the semi enclosed shallow lagoon will become major travelling rout between the airport and Gadhdhoo particularly in times of rough seas.
- The council requested to keep the rout accessible for travellers even during commencement of construction work and after the start of operation in the islands.
- They also understand the importance and need to have a proper and reliable road network between the island for smooth operation of the activities and hence they suggested to build a walkway-bridge on pillars which will also allow passing small dingy and speed boats.

Figure 54: Stakeholder consultation with Gadhdhoo Council members helt on 27th January 2016

10.4 GADHDHOO FARMERS AND PUBLIC

General public and the farmers of Gadhdhoo were invited for the consultative meeting through public announcement using the island loud speaker, which is the common method used by the island council to make announcement. The meeting was held on 30th January 2016 from 21:00 to 22:00 hours in front of council office at the main road. Large number of Gadhdhoo farmers use nearby Gan Island for agriculture. Special effort was made to ensure participation of Gadhdhoo farmer in the consultation meeting. The meeting was attended by over thirty members from the general public, farmer and other community groups.

The consultant gave an over-view of the proposed agriculture development project in the four islands and a background on the type of farming that is proposed to conduct. Also explained how it is going to be sustainable and environmentally friendly and how it is going to introduce state of the art green technologies through the activities in Hulhuvaarulaa Menthandhoo Golhaalaa and Dhoonirehaa.

The consultant opens the discussion for public to raise any concern if they have and/or to express their expectations from the project and overall benefits expecting for the livelihood of the community particularly for improvement in their agricultural practices.

The general public is very much in favour of the project and they want the practical work of the project to start as soon as possible. The public believes that the island will greatly benefit from the development directly and indirectly through creation of employment opportunities during construction and operational phase of the project, increased income, improved services and flow of much needed foreign currency into the economy. They also believe that they can learn good farming practices from this project which will be an important indirect benefit from the project. They also requested as part of CSR to conduct information and awareness workshops on farming practices and technologies as well as marketing and management of agricultural produce. They also request to provide information leaflets and booklets etc., for local farmers in Gadhdhoo. The public is at the opinion that there will be no conflict of interest in terms of the competition for marketing agricultural products as the scale and types of the produce from the proposed activities will be very different from the on-going agriculture practiced by Gadhdhoo people in Gan. The public also reiterated the requested made by the council earlier to keep the shallow water rout in between the islands accessible for travellers even during commencement of construction work and after the start of operation in the islands.

In response to public requests regarding information and awareness activities the consultant said that the matter will be brought to the proponent of the project and it is very likely that naturally similar activities will be conducted for the farmer of Gadhdho and nearby island. With regard to the route accessibility to the shallow water rout between the island the consultant promised to bring-up the issues to the proponent and discuss the likely option to address the request.

At the end the public promised that they will give their full support and cooperation for the project and expressed that they are eagerly looking forward to see the practical implementation of the project activities in the island. They strongly believe the people of Gadhdhoo will be directly and indirectly benefited from the project. A list of names of the general public participated in the meeting is given in Annex 9.

Figure 55: Stakeholder consultation with farmers and general public Gadhdhoo

10.5 MEETING WITH MOFA

As requested in the TOR a separate meeting was arranged with the Ministry of Fisheries and Agriculture (MoFA). The Meeting was held at the meeting room of MoFA at 10 am on 15th May 2016 to discuss the project activities and any concerns they might have on the project. Project engineer Dr. Paolo gave an extensive background on the concept and technical details of the project and updated on the on-going work of the project. He also explained various environmentally friendly technologies that will be adopted for power generation, water and sewerage management and disposal, waste management, greenhouses, deep water cooling system etc.

Director from the Ministry indicated environmentally important components that will need to answer in the EIA report and highlighted large scale vegetation clearance, and specially removal of large trees, waste management, water management and types of crops that will be cultivated in the green houses.

Project engineer Dr. Paolo addressed all these issues and gave snapshot of the planned and concept of the project to address all these issues. Dr Paolo gave a very comprehensive response to their question and more status update on the on-going task including the recent surveys etc. At the end of the meeting Dr. Paolo requested them to give some feedback on the project based on their understanding and they promised to email their feedback at a later stage, they took our contact numbers and we thanked them for their continuous support.

Main conclusion from the meeting is that MoFA is well aware of the project and they want see progress in project implementation and proceed with the EIA process as planned. The ministry ensured its cooperation and assistance whenever requested. The Ministry is looking forward for successful implementation and start of work and the ministry's policy is to ensure that the proposed development in the four islands to go ahead as planned.

Figure 56: Stakeholder consultation with MOFA

10.6 CONSULTATION WITH MFDA

Stakeholder consultation with Maldives Energy Authority (MEA) was held at 11.30am with Shathish Mousa. The consultant and the project engineer Dr. Paolo represented the proponent. MFDA confirmed reiterated that their responsibility lie in health and safety issues of the products. MFDA's primary role is to ensure the process of production follows internationally accepted norms of HACCP (Hazard Analysis and Critical Control Points). As such their role at this stage of the proposed project will come after the construction and before the start of operations. But he indicated that MFDA is working on adoption of GAP (Good Agriculture Practice) certification by FAO in agriculture sector. He then explained more about the certification process and requirements as well as the benefits for marketing and maintaining standards of the produce. He also recommended that HBF farm take this certification in their mind while developing the firm and obtain it prior to opening for business. The consultant and project engineer reaffirmed that HBF will look into the matter very seriously and will probably try obtain either prior to commencement of firm operation or at an early stage of the operations.

10.7 CONCLUSIONS OF STAKEHOLDER CONSULTATION

Following conclusion can be drawn from the various consultations held with stakeholder. The island council is not in favour of constructing a solid causeway between Methandhoo and Hulhuvaarulaa and the main conclusions form the Gadhdhoo council and Gadhdhoo public consultation are:

- The semi enclosed area between the four island is ecologically very significant area as it provides habitat for many juvenile fish, and rays
- The causeway if established will block the passage and travel rout to the remain island in the reef system
- Work is underway to develop Maavaarulaa airport, once it is operational the semi enclosed shallow lagoon will become major travelling rout between the airport and Gadhdhoo particularly in times of rough seas.
- The council requested to keep the rout accessible for travellers even during commencement of construction work and after the start of operation in the islands.
- They also understand the importance and need to have a proper and reliable road notwork between the island for smooth operation of the activities and hence they suggested to build a walkway-bridge on pillars which will also allow passing small dingy and speed boats.
- Requested to conduct capacity building information and awareness workshops and to provide information leaflets and booklets on good farming practices as part of CSR of the project.

- No conflict of interest is anticipated to rise in terms of competition between the locals and the project for marketing agricultural products as the scale and types of the produce from the proposed activities will be very different from the on-going agriculture practiced by Gadhdhoo people in Gan.

MFDA's role at this stage of the proposed project will come after the construction and before the start of operations. MFDA is working on adoption of GAP (Good Agriculture Practice) certification by FAO in agriculture sector. MFDA recommended that the HBF firm to consider obtaining GAP certification for their produces.

MoFA is looking forward for successful implementation and start of project work and the ministry's policy is to ensure that the proposed development in the four islands to go ahead as planned.

Table 15: List of participant their contact details list of people attended public consultation is given in Annex 9.

Name	Office/Designation	Contact
Rifaath Hassan	MoFA Project officer	Rifaath.hassan@fishagri,gov.mv
Ali Amir	MoFA /Director	Ali.amir@fishagri.gov.mv
Ismail Rasheed	MoFA	Ismail..rasheed@fishagri.gov.mv
Paolo Matelloni	HBF/ Engineer	paolo@evolvegrowingsolution.co.uk
Mohamed Hamdhaan	EPA /AD	
Ahmed Anwar	MEE/Environment section	
Ibrahim Falah	HBF representative	
Dr. Mahmood Riyaz	Consultant	7890307
Mohamed Ahmed	President Gadhdhoo council	
Mohamed Shujaau	Vice President Council	
Abdulla Sadiq	Council member	7781721
Ahmed Yameen	Council member	7802244
Ahmed Rishaan	Council member	7785621
Sathish Moosa	MFDA	

11 POTENTIAL IMPACTS AND MITIGATION MEASURES

Possible impacts arising from the proposed agriculture development project in Gdh Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa are categorized into reversible and irreversible impacts. Reversible and irreversible impacts are further categorized by intensity of impacts (negligible, minor, moderate and major) for identifying best possible remedial (mitigation measures) action to be taken. Below are the impact categories

- Negligible: the impact is too small to be of any significance (Reversible)
- Minor: the impact is undesirable but accepted (Reversible)
- Moderate: the impact gives rise to some concern but is likely to be tolerable in short-term, or will require value judgment as to its acceptability (May or may not be Reversible)
- Major: the impact is large scale giving rise to great concern; it should be considered unacceptable and requires significant change or halting of the project (Irreversible)

Leopold Matrix (Leopold et al. 1971) has been used to classify the magnitude and importance of possible impacts which may arise during the constructional and operational phase of the agricultural development project in the four islands. Leopold Matrix is the most widely used methodology for identifying the impact of a project on the environment. It is a two dimensional matrix which cross references between the activities which are foreseen to have potential impacts on the environment and the existing conditions (environmental and social) which could be affected. Leopold Matrix of development project is provided in Annex 5.

The impact matrix should not be misinterpreted to mean that all the identified impacts would occur during implementation of the project. However, the matrix does serve to identify the potential impacts and significant concerns and this leads to the next step of the EIA process, mitigation, which considers the appropriate measures to remove or ameliorate the adverse impacts that have been identified. At this stage measures to enhance the positive aspects of the development can also be devised.

Severity of impact is assessed by reviewing the engineering design, detailed site plan as well as comparison of development with the existing environment and construction methodologies employed. Mitigation measures are derived based on the site specific assessment as well as similar project elsewhere in the Maldives.

The proposed agriculture development project involves dredging of an entrance channel, small harbour and backfilling of the harbour area and island levelling using the dredged material and maximum of 10 hectares of vegetation clearance in the three phases of development, installation of deep water cooling system and development of other necessary infrastructure for the agricultural farm operations .

11.1 IMPACT IDENTIFICATION

The following section describes in detail and discusses the main potential environmental impacts that have been identified and predicted for the proposed agricultural development on the cluster of four islands, Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa Gdh Atoll. Identified potential impacts are divided into construction phase and operation phase environmental impacts.

11.2 LIMITATION/UNCERTAINTY OF IMPACT PREDICTION

The methods used to prediction and evaluation of the environmental impacts that may be associated with the proposed agriculture development in Gdh. Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa

Islands may not be very robust, accurate and the most comprehensive. Accuracy of impact prediction can only be improved through experience and from continued monitoring of similar projects. EIA monitoring is poorly implement and the monitoring data is rarely available for handful of projects. Thus, reasonably reliable data good enough for environmental impact prediction during the EIA preparation process is not available. Therefore, the main shortcoming of these methods is that impacts are predicted by reviewing the survey data collected during the field visits and information revealed by the designers and engineers, also, the data collected during the field visit is limited, which subsequently limits the overall understanding of even the short term environmental conditions (wave condition, currents, and littoral movement). Nonetheless, within the time limitation of EIA field data collection and report preparation the methods used are concise and provide a general overview as well as the range of impacts that can affect the environment to a fairly certain level.

11.3 IMPACTS AND MITIGATION MEASURES CONSTRUCTION PHASE

Construction phase can be considered as the period in any developmental project that causes major direct and indirect long and short-term impacts on the environment. Anticipated potential direct and indirect environmental impacts from the proposed development in Gdh Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa includes the following:

- Mobilization of Equipment and Labour
- Marine habitat and coastal environment
- Dredging reclamation and subsequent sedimentation
- Ground water extraction
- Loss of Aesthetic quality
- Noise, Vibrations and Air Pollution
- Loss of Flora and Fauna during construction
- Equipment & vehicle maintenance
- Impact from waste
- Socioeconomic impacts

11.4 TERRESTRIAL IMPACTS

11.4.1 Impacts from Mobilization of Equipment and Labour

Heavy machinery equipment and material needed for the proposed development will be transported to the islands via barges and cargo boats. Barges can be accessible to the islands only after the access channel and harbour is developed. Once the harbour is developed Hulhuvaarulaa will be accessed and then transported to other islands and bring the equipment and material through a walkway jetty connecting the islands and Hulhuvaarulaa.

A temporary workforce of around 20-30 persons will be working on the site during the construction phase. Until the accommodation blocks are constructed all the workers will be accommodated in Gadhdhoo island in rented houses and they will be commuting between the islands daily. Minor number of construction workforce would be accommodated in temporary shelters in the island during the construction phase.

One of the most important environmental impacts may be generated from improper sewage and waste disposal mechanisms. Raw sewage may harm the marine environment as a result of contamination, which may cause an increase in coliform levels in seawater, eutrophication and coastal water pollution. Such

impacts have potential in threatening the survival of both coral and fish communities found in the reef environment.

Improper and inappropriate methods of domestic waste such as kitchen garbage, construction waste such as cement, iron and concrete as well as other waste such as paints, wastewater and waste oil disposal will impose serious implications on the environment through various negative impacts. The most significant impacts associated with such waste disposal on the island environment range from reduced aesthetic beauty of the of the island and reef environment, marine pollution to water quality degradation, increased sedimentation and turbidity as well as changes in the reef community structure.

During constructions, a number of construction machinery will be used on the island including loaders, concrete machines, earth moving vehicles, pickups, cranes, etc., which may have direct impacts on the island including compaction and cracking of the ground due to the heavy load. Operation and movement of such machinery and heavy load have the potential to damage the environment of the island. In addition to environmental damages, use of construction machinery generates sound, vehicular emissions and dust, may however, temporary in nature (Table 16).

Table 16: Impacts of mobilization of labourers, machineries and equipment

Impacts	Causes	Significance	Mitigation measures
Degradation of existing groundwater	- Increased abstraction of groundwater for the use of labourers. - Oil spillage from vehicles (lorries, excavators) - Mishandling of solid (non-biodegradable) waste - Vegetation clearance to make roads and pathways	- Minor adverse	- Use water from the installed desalination plant - Fuel handling should be done under careful supervision and regular monitoring - Construct proper sewage treatment plant at an early stage of development - Litter bins should be kept at easily accessible locations with proper warning signs to reduce littering and dumping waste on the island
Shift in existing ecological regime of the island	- Disturbances to the existing fauna on the island by the labourers (e.g. collection of turtle eggs, birds etc., increased noise and vibration levels)	- Minor adverse	- Areas should be clearly marked for tree clearance area - Vegetation that needs to be retained should be clearly marked and communicated to

	- Lack of awareness or concern to preserve the environment may lead to deliberate or inadvertent damages to the existing flora and fauna of the island		the workers - Signs should be placed to guide the workers on proper environmental care - Project managers should control the workforce and confine their activities to the project area

Mitigation Measures:

- Areas should be clearly marked for construction activities;
- A specific area should be designated in the coastal area for landing and material loading/unloading;
- Large trees and vegetation that needs to be retained must be clearly marked and communicated to the construction workers;
- Signs should guide workers to proper environmental care;
- Use water collected from the temporary shelters for potable water;
- The supervisor should check compliance of the workers to the environmental guidelines set for the project including avoidance of removal of unmarked vegetation, proper waste management, marine water pollution and ground water pollution.

11.4.2 Impact on ground water table

Size of the ground water is very limited in the islands. Development of ground water reservoir is dependent on the length and width of the island. As mentioned earlier the water quality of the island is good for human consumption and for water watering plants. However due to the size of the island it is expected that the island aquifer will be very small and usage could be minimal. Groundwater also plays an important role in sustaining the ecological system of the island. Extraction of groundwater for construction purposes may prolong the water lens development process and increase the potential for saltwater intrusion into the groundwater aquifer. Increased salinity will generate some environmental consequences such as vegetation that are dependent on freshwater for survival will be deteriorated. As a consequence, more salt tolerant plant species will have the potential to dominate the island environment. Moreover, groundwater can be impacted by the sewage effluent from the construction workforce. Sewage is characterized by high levels of biological oxygen demand (BOD), ammonia and E-coli. Exposure to sewage contaminated water poses various health risks and can cause allergies. Although ground water will not be used for human consumption in the island, it is important for the trees and shrubs in the island. Therefore, special care should be taken when handling oil, solid waste and hazardous waste to entirely avoid any accidental spills and leakage.

Mitigation measures:

- All paints, lubricants, and other chemicals used on site will be stored in secure and bunded location;

- Oil, solid waste and hazardous waste will be handled carefully and transported in sealed containers in properly bunded vehicles/vessels;
- Construction activities will be carried out under the supervision of a suitably experienced person;
- Vessels, equipment and machinery used for the work should be properly maintained at all times during the operation;
- Littering and accidental disposal of any construction wastes can be avoided by pre-planning modalities for waste disposal or re-use wherever possible. Careful planning of the work activities can also reduce the amount of waste generated.

11.4.3 Loss of terrestrial vegetation and fauna

Vegetation clearance is anticipated to be the most significant negative, irreversible environmental impact of this project. During the development phases of the project a total of 10 hectares of vegetation will be cleared. The total vegetated area of Hulhuvaarulaa is 251,092m2, Golhaalaa 150,588m^2, Menthandhoo 104027 m^2 and in Dhoonirehaa 52336m^2. Vegetation clearance required for land based construction, including pathways etc., is approximately 73664m^2 in Hulhuvaarulaa, 21,000m^2 in Menthandhoo, 21,000m^2 in Golhaalaa and 1388m^2 in Dhoonirehaa. This represents vegetated area of approximately 29% of Hulhuvaarulaa, 20% Menthandhoo, 13% of Golhaalaa and 2% of Dhoonirehaa. Types of trees that fall into the development foot print are shown in Figure 10 and Figure 30 .

The number of large and medium sized trees to be cut down is between approximately 2000 to 5000 trees. All of the vegetation falling within the footprint particularly the green houses will need to be permanently removed. Major impacts of vegetation clearance include the following.

- Loss of vegetation means, loss of fauna that depend on those vegetation. Such species include birds, rats, fruit bats and invertebrates.
- Degradation of the topsoil due to exposure to sunlight and heavy rainfall.
- Earth work and ground excavations will completely denude epi-fauna, borrowing and sedentary organism on the substrate. Mobile fauna, such as fish will swim away and will not be affected.
- Coastal vegetation clearance can lead to coastal erosion. These salt resistant plants play a key role in stabilizing the beach by consolidating the sand and by acting as a natural barrier between the shore and the inland areas.
- Removal of inland vegetation leads to exposure of top soil which can lead to runoff of soil nutrients to sea leading to loss of soil fertility and increase in eutrophication of coastal waters .

Mitigation measures

- Strict guidelines and construction monitoring is required during the vegetation removal stage to ensure that every single tree could be replanted elsewhere.
- All clearing works will be carried out during day time to minimise disturbances caused to nocturnal fauna such as birds and fruit bats that uses auditory communication.
- All vegetation clearance activities should be confined to areas where infrastructure is proposed.
- A strong coastal vegetation is contributing factor to the natural defenses of an island, especially at times of ocean induced flooding, strong winds and against coastal erosion. Maintaining a robust coastal vegetation belt is required to mitigate against natural hazards. Broad vegetation belt, is recommended throughout the island for reducing certain ocean induced hazard exposures.

11.4.4 Noise, Vibrations and Air Pollution

During the mobilisation of equipment and operation of heavy machinery, it is anticipated that significant noise will be generated. In addition, dust and emissions from vehicle and machinery exhausts will degrade the air quality. However, these adverse impacts will be short term and can be mitigated to avoid nuisance. With proper mitigation measures, it is unlikely that noise, vibration and air pollution impacts

will cause long term effects such as human health risks leading to increased public and private health costs.

11.4.5 Loss of Aesthetic Quality

Removal of vegetation and soil for construction of facilities and piling up of construction waste as well as a number of construction vehicles on the island often depletes the aesthetic quality or the natural beauty of the island. Since the ecosystem of the island is naturally balanced, such activities may deteriorate the ecological integrity of the island as a result of pollution.

11.4.6 Equipment & vehicle maintenance

All sorts of motorized equipment, from generators to trucks, requiring fuel, lubrication and maintenance will be used on the construction site. Many will be fitted with lead batteries. Therefore the potential will exist on the site for spillage and contamination of the soil and the sea by hydrocarbons as well as the careless disposal of batteries.

Mitigation measures:

- Confine vehicle maintenance to specially prepared areas with impermeable pads.
- Ensure changed engine oil is collected in drip pans and stored in covered drums until it can be properly removed from the site for appropriate disposal
- Ensure used batteries are properly stored and kept under cover.

11.4.7 Impacts from Waste

Inappropriate disposal of construction waste or remains of earth work or temporary waste mounds on vegetation could destroy them or will cause significant negative impact on the environment. Often construction activities generate large amounts of construction waste and disposal of such waste material into the island and surrounding environment often pollutes the island environment. Disposal of construction material such as cement, concrete, oil, paint, cleaning agents will damage both flora and fauna found on the island as well as will contaminate the groundwater lens of the island. Groundwater pollution negatively impacts the environment by deteriorating the flora and fauna of the island. Additionally, disposal of construction waste into the immediate surrounding marine environment will pollute the marine and coastal waters as well as will have direct and indirect consequences on coral reefs and associated habitats. For instance, corals and reef fish may instantly die off as a result of severe pollution. Strict measures will be followed and implemented on generation, disposal and monitoring of solid waste during the construction period. Solid waste, waste water and sewage generated by the workforce may affect the groundwater and general terrestrial environment of the island

Mitigation measures

- All hazardous and dangerous waste such as fuel, empty paint buckets, broken glass etc will be separated and transported to waste management site in Thilafushi.
- Contractor will be required to train staffs to ensure appropriate and efficient separation of solid wastes at the point of source;
- A solid waste reduction strategy will be implemented with the goal of decreasing the amount of packaging materials arriving on the island, with specific attention to cans, bottles, and plastics.
- Containment and control of waste
- Awareness of potential waste issues among employees and workers

- Commitment to good solid waste management practice

11.4.8 Impact on marine habitats

Direct impact to marine and coastal environment associated with the proposed project will mainly be from access channel and harbour dredging work and installation of deepsea cold water system. These activities will have a direct irreversible negative impact to the ecological marine and coral reef habitat of the reef. Impact footprint of marine work construction work is shown in Figure 10. Direct impact of this activity is limited to western side of Hulhuvaarulaa, and eastern side of Menthandhoo, and Dhoonirehaa reef only and to the island. This includes:

- Loss of habitat in reef flat and lagoon area
- Physical damage on live coral and loss of live coral: The effect of this would be in the immediate to medium term with the loss of substrate and its fauna.
- Physical damage to live corals and loss of live corals
- Change of near shore hydrodynamic and longshore current pattern
- Degradation of sea water quality due to turbidity
- Sedimentation and associated impacts explained
- Physical disturbance of the lagoon substrate will result in loss of habited for some lagoon infauna such as polychaete amphipods, worms, and mollusks etc.

Mitigation Measures: A range of possible outcomes is expected as have been mentioned. The most important mitigation measure is to monitor the area and respond to the changes in the coast line.

In order to minimize the impact from sediment, dredging should be completed in shortest time possible. Dredging ought to take place during low tides or slack tides to minimize the release of sediment to the area.

Installation of turbidity screen at the outer boundary of the channel and harbour dredging area and harbour backfilling area will reduce the sedimentation

11.4.9 Damage to coral reef and seagrass communities

Dredging, reclamation and subsequent sedimentation
Entrance channel and harbour basin dredging and backfilling harbour area, installation of deepsea cold water intake and outfall pipeline related work will have a direct irreversible negative impact to the ecological habitat of the coral reef and the seagrass bed in the area. Direct impact of this activity is localized and limited to the western side of Hulhuvaarulaa and eastern reef flat of Dhoonirehaa and Menthandhoo reef only.

Given below are relevant impacts that should be considered:

Physical damage on live coral and loss of live coral due to trenching for pipeline and access channel dredging: The effect of this would be in the immediate to medium term with the loss of substrate and its fauna.

Disturbance to the area during dredging activity: Release of sediments and potential loss of the faunal composition underneath sediment material will undoubtedly occur.

Dredging and harbour area backfilling will erect a shore perpendicular structure that will change in the flow patterns. Current flow can be quite significant on the shallow reef flats and deeper areas will dampen the flow. The unexpected outcome may be erosion or accretion on either side of the harbour.

Alteration of reef flat and lagoon substrate habitat and infauna approximately 8875 m^2 will be directly and irreversibly altered from dredging and reclamation.

Excavation for pad-column foundation for the walkway between Hulhuvaarulaa and Menthandhoo will disturb the shallow water and sea bottom habitats of the semi enclosed area between the islands and will directly alter benthic faunal composition of the area through sedimentation and direct disturbance

Mitigation Measures

In order to minimize the impact from sediment, dredging should be completed in shortest time possible. Dredging ought to take place during low tides or slack tides to minimize the release of sediment to the area.

As a mitigation measure it is recommended to relocate the live coral colonies that fall directly on dredging area to the shallow reef flat on the western side of the reef prior to starting dredging activities.

Installation of turbidity screen at the outer boundary of the channel and harbour dredging area and harbour backfilling area will reduce the sedimentation

11.4.10 Protected areas and protected species

The nearest areas that are listed in the EPA's environmentally sensitive areas list are Mariyamkoae rehaa, Gadhdhoo Kandu and the Gan turtle beach. These areas are fairly far from the project site. The nearest is Mariyamkoae rehaa located approximately 3.4km south west of the project site. The remaining two areas, Gadhdhoo Kandu and the Gan turtle beach, are located 6 and 7km south of the project site (Figure 57). based on the project activities the only likely impacts of the project to the sensitive sited would be from dredging, reclamation and reef excavation activities. But due to the fact that these sites are being located far from the site it would be very unlikely that the areas will be impacted by sedimentation from channel and harbour dredging work and reef excavation to lay the deep sea water intake and outfall pipe.

Figure 57: Environmentally Sensitive areas near the project site

11.4.11 Impact from dredging and reclamation

Sedimentation

The principal determinant of sediment mobility during dredging and reclamation process is wave and current action. Suspended sediment mobilised by wave and current action is determined by the prevailing wave energy and the depth. The wave induced water particle motion drops off with the depth. Sediment disturbed in the relatively shallow waters of the lagoon will drop out of suspension in the deeper water into the atoll lagoon or the deeper reef. It should be noted that the closer to the reef edge, the higher the wave energy. The increased energy may offset the increase in depth, the sediment may stay in suspension. In its fluid state however the sediment is readily disturbed by any significant wave action anywhere in the lagoon.

The tidal currents however are not strong enough to mobilise the sediment from the substrate into suspension by themselves, they act only to transport the sediment once suspended. Therefore conducting the dredging and reclamation during low tides will help to limit the mobility of suspended sediments in the area. If dredging and reclamation work is conducted during the NE monsoon period suspended sediments from dredging will be moving towards SW into the atoll lagoon. Therefore coral reef-flat on the western side will be impacted from dredging and reclamation activities.

Direct impacts from access channel and harbour basin dredging and backfilling related sedimentation will be limited to reef on the western side of Hulhuvaarulaa and impact from excavation to lay the deep sea cold water intake and outfall pipe will be limited to the eastern reef of Dhoonirehaa, however nearby reefs might be impacted with sedimentation. Impacts of excessive sedimentation on corals include:

- Direct Physical smothering of corals and benthic organisms
- Direct physical damage to the reef flat on the eastern side of Dhoonirehaa from excavation
- Reduced light penetration and subsequent reduction in photosynthesis productivity of coral reef growth, calcification and reproduction
- Shifting unstable sediments will form a false bottom
- Increased amount of sediment will cause eutrophication which will increase the amount of nutrients and lead to algal blooms
- Formation of anoxic black bottom beneath the fine sediment
- Suspended sediment in the sediment plume may trap pollutants which are absorbed into the sediments.
- Short term turbidity increase in lagoon water column during dredging and reclamation will result in decrease in fish and other pelagic populations.

Mitigation measures

- To reduce the impact of sedimentation dredging work will be carried during low tide and calm water condition to minimize effects on the reef.
- Installation of turbidity screen at the outer boundary of the channel and harbour dredging area and harbour backfilling area will reduce the sedimentation.
- Installation of silt screen or a geomembrane will reduce the siltation issues related with dredging and reclamation.

11.4.12 Change in erosion/sedimentation pattern

The proposed dredging reclamation in the form of harbour backfilling can only influence the wave energy environment around the island through reflection and refraction and subsequent shoaling of the incident waves.

Waves within the cluster of islands (Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa) generally fall into two categories, locally monsoon derived wind generated fetch waves with a period of

3-8 seconds and swell waves from more distant storms with a period of 14-20 seconds (DHI, 1999) waves break on the western side of Hulhuvaarulaa and eastern side of Dhoonirehaa respectively. Wave directions exhibit seasonal variations with local monsoon generated wind waves which are typically strongest during April-July in the south-west monsoon period.

Extension of shore perpendicular harbour structure adjacent to the shoreline will effectively alter the alongshore sediment and current flow pattern. Sediment dynamic studies around elongated islands such as Hulhuvaarulaa is characterized by constrained excursion of the beach, partitioned sediment movement process and beach change encompasses minor sector (Kench et al 2003). Therefore the erosion/sedimentation pattern on the western side is expected to be show changes on either side of the harbour area in sections alternated by the monsoons.

The 425m long access channel will be filled with sediment by time this will cause in sediment starvation in other parts of the lagoon. Also the infilling of the lagoon will make it shallower and may require frequent maintain ace dredging. Frequency will be dependent of the rate of filling which can only be determined through long term monitoring of sedimentation rate.

Mitigation measure
Avoid permanent and solid shoreline attached structures (harbour)
Detached harbour from the shore line
Detached harbour connected through a piled jetty
Continuous monitoring of shoreline dynamics and respond to changes accordingly

11.5 IMPACT ON THE SOCIO ECONOMIC ENVIRONMENT

11.5.1 Negative impacts

The cluster of four islands, Hulhuvaarulaa, Menthandhoo, Dhoonirehaa, Golhaalaa are vegetated used by locals to mine coral sand for construction purposes particularly by the local population from Gadhdhoo Island. Agriculture development on the islands will bar the use for sand mining. Since there are many islands and vast shallow lagoon area with adequate sand to mine this would not be a major problem for Gadhdhoo people. Also these islands are used by local people from Gadhdhoo for picnic and collect firewood and coconuts. Accessibility of the islands for such purposes will not be possible with the commencement of work on the islands.

The passage between the island is used by the local people as a transport route between the islands in the reef. A new domestic airport is being development on Maavaarulaa the northern end of the reef platform. Once this airport becomes operational demand for the use of the passage, particularly in rough weather conditions, will be increased. Therefore it is very important to remain the passage accessible for small local dingys using the route for transportation between the airport and Gadhdhoo

Mitigation measures:

- Island council should engage in a dialogue with relevant authorities and the proponent on the condition for the accessibility of the passage between the island as a transport route once the commencement of operations in the islands.

11.5.2 Positive Socio-Economic Impacts

Socio-economic impacts of agriculture development in Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa can be summarized largely as beneficial for the Maldives and nearby atolls and islands. Direct benefit of the development to the nearby islands, particularly Gadhdhoo, and atolls in general include creation of employment opportunities during construction and operational phase of the project,

increased income, improved services and flow of much needed foreign currency into the economy. The following direct and indirect benefits are identified for the Maldivians particularly for the islands nearby in the following economic sectors

- Creation of competitive agriculture market for locally grown fruits and vegetables;
- Employment: Temporary (10-30 job opportunities during construction period) permanent (over 10-20 jobs during operational phase);
- Development of business opportunities in supply and services; and
- Capacity building opportunities in modern farming techniques and technologies.

Overall the proposed development in Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa will increase government revenue and contribute to expansion of service industries as direct benefits of the project. Indirect benefits of the project include improvement of public facilities and infrastructure, general improvement of social conditions and service industry activities, in addition to the increased national agriculture and economic infrastructure.

11.6 IMPACT ANALYSIS

Environmental impact from the project was assessed using (Leopold et al, 1971) matrix. Numerical values ranging from 1-10 are given to all the activities of the project to measure the magnitude and importance of an impact. Magnitude and importance of the impact is judged based on the environmental data, experience and based on the similar assessment carried out by the consultant in similar environments.
The impact matrix for the proposed agriculture development project in Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa showed that vegetation clearance, harbour and access channel dredging work, earthwork and levelling and martial stockpiling are the most important activities during the construction phase that will result in negative impact on the environment. Also the analysis showed that rainwater harvesting, staff trains and operation of agricultural farms will have positive impact on the environment, as these activities will contribute to the recovery of environmental damages caused by the construction activities. The assessment also showed that the overall the project will have very positive cultural and socio economic impact. Apart from the negative impacts mentioned above the remain impacts from the construction and operational phase of the project are moderate and/or minor/negligible negative impact on the environment. Impact matrix is shown in Table 17, a larger version of the matrix is presented in the Annex 5. Table 18 presents significant impacts, mitigation measures and associated costs for the proposed agricultural development project. The Proponent has committed to bear the financial expenses of the proposed mitigation measures Annex 7

Table 17: Leopold Matrix, impact assessment, for HBF project in GDh. Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa magnified view of the matrix is presented in Annex 5.

			Construction Phase													Operational phase								
			Activity																					
			Mobilization of Equipment and Labour	Vegetation Clearance	Harbour, access channel dredging & reclamation	Seawater cooling system	Advanced hydroponic greenhouses	Solar power grid for Energy system	Fuel storage	Earthwork and levelling	Heavy vehicle operation, noise, air quality dust	Sewage and litter management	installation of utilities	Rainwater harvesting & condensate water collection	material stock pilling	Fuel and chemical storage handling and use	solid waste management	Equipment & vehicle maintanace	Staff training	Water and electricity demand	Agriculture farm operations	Sewage disposal	Harbour operations and transportations	Total
I- Physical and Chemical Chracteristics	1.Land	a.Soil	2 4	9 9	3 3		2 4	4 5	3 4	6 6	4 5	5 5	5 7		5 4	1 4	2 3	1 1	+4 4		1 2			49 62
		b. landscape	1 2	7 9			4 6	4 5		6 6	2 2	3 1	2 4		4 5	2 3	2 3		+4 4		3 4			36 46
	2.Water	water table contamination	4 5	5 5	2 2		1 2		2 3	5 5		5 2	3 3	+10 8	5 5	2 3	3 4	2 2		+8 5	1 2			25 30
		interaction with surface driniage	2 4	5 7						5 6	4 3	2 1	3 3	3 3	5 6		4 4	2 2			2 1			37 40
		change in water quality	1 2	5 6						4 5	3 1	5 2	2 2	+9 7	6 7	3 3	5 5	1 2	+4 4	+8 5	1 2			18 21
		runoff charactersitics	2 2	6 7	2 5					6 5	2 2	1 1	2 2	+3 2	2 5		3 2				1 1			49 30
	3. Amosphare	a. air quality (gases, aerosol)	4 5					+4 5	5 6	5 5	4 5	3 3	3 3		5 5	2 3	3 3	2 3	+4 4	4 3	1 1		3 2	33 38
		b. Climate		2 5					5 5	3 2										+8 7	+8 7			+6 +2
II-Biological Conditions	1. Coastal and Marine Resources	a.current sediment dynamics			9 10	3 5													+4 4		3 3	+2 2	5 4	14 16
		b.lagoon water quality (turbidity)			10 6	2 3				1 1		4 3				2 2	3 4	3 3	+4 4		2 3	+3 3	5 4	25 22
		c. coral	1 4		10 6	5 2						3 2							+4 4		2 1		3 1	20 12
		d.sandy bottom creatures		7 8	10 6	5 2					2 3	3 2	2 2								2 3	+3 3	2 1	22 25
		e. beaches	4 5	5 7	10 6	2 2					4 5	2 2	1 2		5 5	3 3	3 3	3 3	+4 4		3 2	+3 3	4 4	42 42
		f. fish and fisheries			7 8																1 1			8 9
		g. Endangered species			7 8																			7 8
	2. Flora	a.trees, shrubs, grass	5 6	9 10		1 1		7 8		6 6	7 7	4 2	2 3	+3 4	6 7	3 3	4 4	4 3	+4 4	+5 5	3 3			49 50
		b. endangered species		5 8				5 6		5 5	3 3	1 1			3 4				+4 4		+8 5			13 18
	3.Fauna	a. birds land animals, reptiles		8 9		2 3	2 3	7 8		7 7	5 5	2 2	3 4		6 5		2 1	3 3			+8 5			42 45
		b. insects		8 9		1 2	2 3	4 5		7 7	5 5	3 3			6 7		5 4	4 4	+4 4		3 2	2 2		45 49
		c. Endangered species		4 8			2 3			3 2											+8 5			4 8
III- Aesthics, Cultural & socio-economic Condition	1. Aesthetics and Human	a.Scenic view and vistas	6 7	10 5	5 7	3 4	6 7	7 8	6 5	6 4	6 5		4 4	3 3	7 6	4 5	6 5	5 4		3 2	3 2	3 3	4 4	97 91
		b.noise/vibration	7 7		4 6	4 5		+3 4	3 4	6 6	7 3	2 2	5 6	4 3	4 5	3 3	3 4	2 3	+4 4	2 1	4 3		3 2	61 63
		c.litter/debris/dust	7 7	8 9	4 6	3 4	1 1			6 7	7 3		5 5	1 1	7 7	1 3	6 6	4 4		2 2	4 4	3 3	5 4	67 76
		d.ordour	2 1		4 4				6 6	2 1	5 2		6 6		7 7	4 3	6 5	5 3		1 1	3 3	4 4	1 1	56 56
		e.Wildness qualities		5 7			3 3	6 7		3 4	3 1		1 2						+4 4		+8 5			12 15
		f.Open space qualities		7 8			4 4	7 7	6 6	4 4	1 1			4 5	6 6	4 4	6 6	4 2		2 2	3 3	4 3	3 2	65 63
		g.landscape design		7 8		1 1	5 5	7 7		4 3	1 1		3 3	3 2	5 6		3 4			3 4		1 1	43 42
	2. Cultural Status	a. cultural patterns lifestyles			+4 5		5 6	+6 6			2 3		3 3	+5 4					+4 4		+6 5		+2 2	+17 +14
		b. health and safety	+3 5				+3 2	+6 6	6 6	5 6	3 3		+8 5	+5 5	5 5	5 5	5 5	3 3	+4 4	3 2	+6 5	3 1	+3 3	+2 1
		c. Employment	+6 7	+3 8	+4 5	+2 3	+3 4	+8 7	+8 7	+6 6	+6 6		+6 6	+4 4	+6 6	+8 5	+8 5	+8 5	+7 4	+4 3	+10 10		+6 6	+87 +101
	economic	bussiness oppertunities	+7 8	+9 9		+2 3	+7 8	+8 8	+7 7	+6 6	+8 5		+6 6	+5 4	+6 6	+8 5	+8 6	+8 6	+8 5	+8 6	+2 4		+9 9	+104 +103
		Total	32 41	102 127	69 71	28 28	24 33	25 30	31 31	93 90	69 55	48 34	43 45	+26 42	92 95	29 37	64 64	38 34	+73 7	+6 18	+7 42	8 5	19 10	
		I = Importance																						
Key	M / I	M=Magnetude																						

Table 18: A summary of significant impacts, mitigation measures and associated costs

ACTIVITY	IMPACTS	IMPACT PREDICTION			MITIGATION MESURES	Mitigation cost (MVR)
		Magnitude	Revers ibility	Duration		
1. Impacts from Mobilization of Equipment and Labour	Degradation of existing groundwater	L	R	S	Establish rain water collection facilities at early stage	Included in the project cost
	improper sewage and waste	L	R	S	Install self-contained electrochemical units at	Included in the project

	disposal mechanisms				very early stage of mobilisation	cost
	inappropriate methods of domestic waste such as kitchen garbage, construction waste such as cement, iron and concrete as well as other waste	M	R	S	Regular check on compliance of the workers to the environmental guidelines set for the project including avoidance of removal of unmarked vegetation, proper waste management, marine water pollution and ground water pollution	
	Operation and movement heavy vehicle generates sound, vehicular emissions and dust	L	R	S	All construction work that produces significant noise should be undertaken during day time to minimize noise pollution. Provide ear muffs for construction workers to wear when using machinery that produce significant noise.	2,000 cost of earmuffs
2. Earthwork and leveling	Increased ground water salinity	L	R	S	Avoid activities that will increase salinity of Ground water, Eg: disposal of dredged material into the land and use for leveling without washing	Staff training
	Pollution of groundwater aquifer	L	R	S	store paints, lubricants, and other chemicals in secure and bunded location; carefully handle and transported oil, solid waste and hazardous waste in sealed containers Proper supervision of Construction activities equipment and machinery at all times during the operation; Establish pre-planning modalities for waste disposal or re-use wherever possible.	
3-Vegetation Clearance	Loss of fauna and habitat. Degradation of the topsoil Denude epi-fauna, borrowing	H	R	L	-Ensure that every single tree removed could be replanted elsewhere. -Clearing works carried out during day time only to minimise disturbances caused to nocturnal fauna -Vegetation clearance	

	and sedentary organism on the substrate. Coastal vegetation clearance can lead to coastal erosion. Exposure of top soil and runoff of soil nutrients to sea leading to loss of soil fertility and increase in eutrophication of coastal waters				activities confined to areas only infrastructure is proposed. -Maintaining a robust coastal vegetation belt to mitigate against natural hazards.	
4- Impacts from Waste	construction waste or remains of earth work or temporary waste mounds will cause significant negative impact on the environment.	M	R	S	-Hazardous and dangerous waste separated and transported to waste management site in Thilafushi. -Implement solid waste reduction strategy - Decrease the amount of packaging materials. Containment and control of waste Awareness of potential waste issues among employees and workers	Transportation cost 2,000
5- Access channel and harbour dredging work	Impact on marine habitats	L-M	R	L	-Dredging should be completed in shortest time possible. -Dredging ought to take place during low tides or slack tides -Installation of turbidity screen at the outer boundary of the channel and harbour dredging and backfilling area	10,000 cost of silt screen installation
	Damage to coral reef and seagrass communities	L	I	S	-Relocate the live coral colonies that fall directly on dredging area prior to commencement of dredging activities. Installation of turbidity screen at the outer boundary of the channel and harbour dredging and backfilling area	As above

	Change in erosion/sedimentation pattern	H	R	L	-Avoid permanent and solid shoreline attached structures (harbour) -Detached harbour from the shore line Connect habour-island through a piled jetty Continuous monitoring of shoreline dynamics and respond to changes accordingly	See alternative harbour design
6-Socio economic	Loss of coral sand mining ground Navigation route	L	R	S	Island council should engage in a dialogue with relevant authorities and the proponent on the condition for the accessibility of the passage between the island as a transport route	
	Employment Creation of competitive agriculture market for locally grown fruits and vegetables; Development of business opportunities in supply and services Capacity building opportunities in modern farming techniques and technologies	L	R/I	L		Benefit to the community and significant economic cost

Key

Magnitude	Reversibility	Duration
H=High	I=Reversible	L= Long Term (Over 10 years)
M=Medium	R=Reversible	M=Medium term (Over 5 years)
L=Low		S=Short term (Below 5 years)

12 ALTERNATIVES

12.1 NO DEVELOPMENT OPTION

It is believed that a number of environmental impacts will be generated from the proposed agriculture development project in the cluster of islands Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa located on Gadhdhoo reef platform. Although no impacts on the environment will be associated if the proposed development does not go ahead, the development of the islands will bring numerous socio-economic impacts to the livelihood of the local community. Commercial agricultural development is a priority in the Sixth National Development Plan which aims at import substitution of crops that can be grown successfully and competitively in the Maldives, as well as to increase food security of its people. The Government's agriculture policy is to increase production and income through more efficient use of the limited land resources, improve the quality and quantity of production, and promote a balanced development in the rural areas through strengthening agriculture. In terms of socio-economic benefits, the proposed agriculture development will bring socio-economic development, introduce new and state of the art environmentally friendly technologies in the field and will create jobs and improve living standard and livelihood of the Maldivians.

Given the range of benefits that the proposed development will bring to the local economy and people, the proposed development project has been considered important. Development can take place only within the limits of the environment and the society. Hence, the aim is to ensure that all project activities are undertaken without any adverse long term irreversible environmental damages that cannot be mitigated. Preferred alternatives discussed below has been selected based on the above broad development concept

12.2 DEVELOPMENT OPTION

Having decided and followed the development option of the proposed project one has to consider the alternative options in the four islands that would have least environment impact. Following have been considered for the alternatives. Most of the elements of the proposed development concept is environmentally conscious therefore not much alternatives that would bring significant change to the project is difficult to find. But some alternatives for some components of the project is suggested below:

12.3 ALTERNATIVES HARBOUR DESIGN

The proposed harbour with a very long access channel is attached to Hulhuvaarulaa shoreline. Extension of shore perpendicular harbour structure adjacent to the shoreline will effectively alter the alongshore sediment and current flow pattern. Sediment dynamic studies around elongated islands such as Hulhuvarulaa is characterized by constrained excursion of the beach, partitioned sediment movement process and beach change encompasses minor sector (Kench et al 2003). Therefore the erosion/sedimentation pattern on the western side is expected to be show changes on either side of the harbour area in sections alternated by the monsoons. Studies by (Kench etal 2003) has shown that erosion and accretion on elongated islands such as Hulhuvaarulaa occurs in sections seasonally. Therefore interruption of sediment movement would alter nearshore processes and sediment transport and can destabilize island shorelines.

In such islands the recommended option would be to develop a detached harbour approximately 100 off the shoreline (satellite harbour) between the shoreline and the reef flat and use a piled jetty to connect the harbour basin and the shoreline (Figure 58).

Given the nature of the proposed development and the fact that fairly heavy load will be transported frequently through the infrastructure, practicality of such a harbour needs to be considered and evaluated as an alternative to the proposed harbour in Hulhuvaarulaa.

12.4 ADJUSTMENT TO THE BUILDING FOOTPRINTS

Old and large trees that will fall into building foot prints are suggested either to keep them in place or adjust the building to avoid such trees. A detailed pinpointing of large trees will be carried out during the early stages of construction phase before commencement of vegetation clearance work. Based on the detailed tree survey adjustment to the building location (alternatives locations) should be selected to avoid particularly large and old trees. Strict guidelines and construction monitoring is required during the vegetation removal stage to ensure that only the necessary tree will be cut down during the vegetation clearance process.

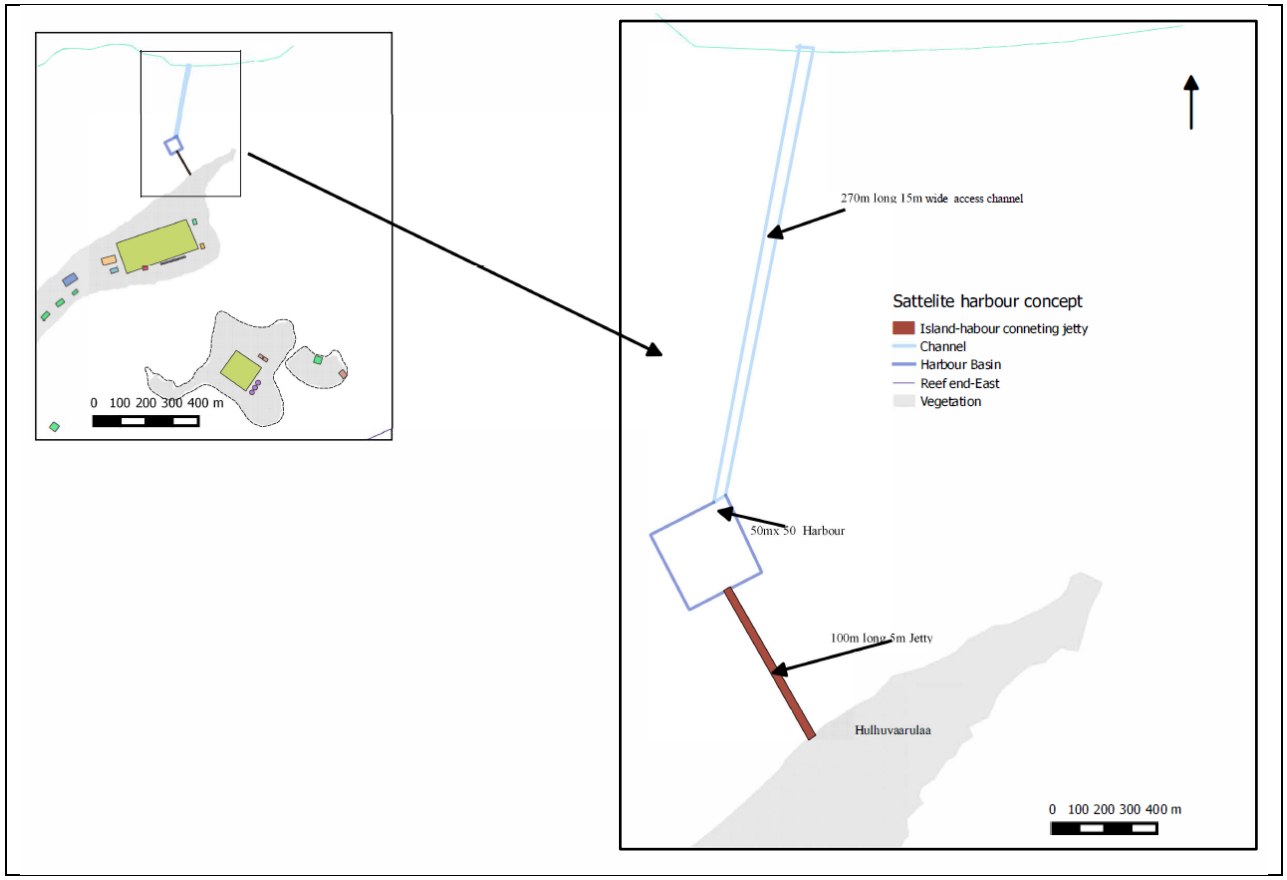


Figure 58: Satellite harbour concept, alternative harbour design for HBF project

13 MONITORING

Environmental monitoring is essential to ensure that post-construction and operational impacts are known and eliminated in a timely manner. Dealing with impacts earlier would save money and also help planning and operationalize the process.

The parameters that are most relevant for monitoring the impacts that may arise from the proposed project are included in the monitoring plan. These include ground water (pH, dissolved oxygen, electrical conductivity, and faecal coliforms), water quality (turbidity, dissolved oxygen, phosphates, nitrates and BOD), sediment deposition. Monitoring the shoreline changes that may occur due to the medium to long term impacts from the changes in coastal processes.

Table 19: Shoreline, Beach Profiles and Coastal Process monitoring schedule

Parameter	Indicators	Baseline / Reference Values	Method / Technique	Frequency	Estimated cost in USD
Shorelines (high / low tides)	Beach morphology	Baseline to be re-established immediately after construction is complete	Differential GPS	4 times (once every three months) is the first two years and twice yearly thereafter	200/ trip
Beach profiles	coastal changes	Requires to re-establish the baseline following the construction	Beach profile surveys	4 times (once every three months) is the first two years and twice yearly thereafter	200 / trip
Currents	Nearshore currents	Baseline to be collected immediately constructions are over, especially on western side	Drogue survey	Bi-annually in the first two year and yearly thereafter	150/trip

Table 20: Coral reef monitoring schedule

Parameter / Method	Frequency of Monitoring	Purpose	Estimated cost (USD)
Benthic cover by major life forms (live, dead, rock rubble and sand)	Annually	Indicative of the changes in the live coral cover	200/trip

Fish population / visual census	Annually	To assess broad scale change in the ecological status of the coral reefs (increase / decrease of herbivores, etc)	

Table 21: Water Quality monitoring schedule

Type	**Parameters**	**Locations**	**Frequency**	**Estimated cost (USD)**
In situ monitoring / sampling and testing from a laboratory	Dissolved oxygen Turbidity (NTU) Nitrates Sulphates COD TDS	All locations marked	Bi-annually	400/ set of tests

13.1 MONITORING COSTS

It is understood that costs of monitoring be borne by the developer of the Resort. It is also understood the mitigation measures would be accommodated in the contract costs. A commitment letter confirming compliance on mitigation measures is given in Annex 6.

13.2 MONITORING REPORT (FORMET AND FREQUENCY)

A detailed environmental monitoring report is required to be compiled and submitted to the EPA annually, based on the data collected for monitoring the parameters included in the monitoring programme.

The monitoring report will include details of the site, strategy of data collection and analysis, quality control measures, sampling frequency, techniques and monitoring analysis and details of methodologies and protocols followed. The report will also include fuel, chemicals and water consumption data and greenhouse gas emission calculations.

In addition to this, more frequent reporting of environmental monitoring will be communicated among the environmental consultant, project proponent, the contractors and supervisors to ensure possible negative impacts are mitigated appropriately during and after the project works

14 CONCLUSIONS

The environmental impact assessment study for agriculture development Project on GDh. Hulhuvaarulaa, Menthandhoo Golhaalaa and Dhoonirehaa Island shows there are two main activities related to the development work that would cause significant negative environmental impacts. However, most severe environmental impact from the proposed project is associated with dredging and harbour backfilling, vegetation clearance and trenching of reef flat and slope to lay the cold water intake and outfall pipe related activities. Anticipated environmental impacts for the islands and the reef from the proposed project in order of significance are:

1. Vegetation clearance approximately total 10 hectares
2. Access channel and harbour dredging, and backfilling harbour area
3. Reef flat and slope trenching associated with the seawater cooling system

Of these clearance of vegetation is significant in terms of loss of ecological habitat and it is an irreversible loss as the area has to be left cleared for the rest of the farming period. However, the positive economic impacts from the development outweigh the loss of habitat.

Dredging, reclamation and trenching on reef flat related to island access, harbour and instalment of seawater cooling system would have long term localised impact on the coral reef and marine environment in the area. Potential erosion/accretion and adjustment of reclaimed land and to create a new equilibrium with the surrounding environmental conditions are likely to extend to medium to long term. These impacts would be cumulative occurring over long period of time and so can be managed through proper monitoring and addressing them in a timely manner. Based on the scale of infrastructure development and land reclamation projects that is taking place in Maldives, impacts associated with the proposed dredging would be insignificant. Close monitoring and strict implementation of the mitigation measures suggested is the report is very important.

The study has evaluated alternative options for the project activities and has suggested alternative design for the harbour. Also the report found, based on the similar project activities elsewhere in the Maldives, the island and the reef will recover from the expected impacts rapidly and will re-establish a new ecological balance soon. However the report has come-up with an extensive monitoring programme that will keep on monitoring the environmental changes associated with the development and make necessary adjustment to the activities of the project based on the findings of various measured environmental parameters suggested in the monitoring plan.

The study has identified the following beneficial effects form the proposed agricultural development project in Hulhuvaarulaa, Menthandhoo, Golhaalaa and Dhoonirehaa:

- Creation of competitive agriculture market for locally grown fruits and vegetables;
- Availability of locally grown high quality salad crops that can cater for the high-end tourist resort
- Employment: Temporary (10-30 job opportunities during construction period) permanent (over 10-20 jobs during operational phase);
- Development of business opportunities in supply and services; and
- Capacity building and technology transfer opportunities in modern farming practices.
- Improvement of public facilities and infrastructure, general improvement of social conditions and service industry activities, in addition to the increased national agriculture and economic infrastructure.
- Better guardianship of the terrestrial and marine resources of the four islands;

- Improvements in environmental quality of the island;
- Stimulation of local economy, cultivation and small business opportunities within the nearby island communities; and
- Increased government revenue and increased GDP.

The study found no evidence that the project requires or involves:

- loss of unique habitat or wilderness areas;
- resettling of local communities;
- removing or destroying cultural properties;
- contravening national government of the Republic of Maldives, or island community policies, regulations, criteria, customs or aspirations concerning environment, economy, employment, cultural traditions or life styles.

On the basis of this environmental impact assessment study and the impact mitigation measures proposed in the report will be duly implemented and recommendations are given due consideration, it is concluded that the benefits of the proposed agriculture development project in Gdh Hulhuvaarulaa, Menthadnhoo, Golhaalaa and Dhoonirehaa will substantially outweigh an unwelcomed demand of burden on the environment.

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16 ANNEXES

Annex 1: EIA Terms of Reference (ToR) Approved by EPA
Annex 2: Letter of award
Annex 3: Landuse plan and concept design
Annex 4: access channel and harbour dredging application
Annex 5: Leopold matrix of development project
Annex 6: Ground and sea water laboratory results
Annex 7: Environmental monitoring and mitigation commitment letter from the proponent
Annex 8: Letter from Council indicating that they have received the EIA report
Annex 9: Stakeholder consultation, scoping meeting attendance and public consultation attendance

203-EIARES/PRIV/2015/668

Terms of Reference for Environmental Impact Assessment for Agricultural development by Humming Boy Farms Pvt.Ltd. in Hulhuvaarulaa, Menthanduaa, Golhaalaa and Dhoonirehaa, GDh Atoll

The following is the Terms of Reference (ToR) following the scoping meeting held on the 12th December 2015 for undertaking the EIA of the Humming Boy Farms Pvt Ltd's sustainable agricultural development project at Hulhuvaarulaa, Menthanduaa, Golhaalaa and Dhoonireha, South Huvadhu Atoll.While every attempt has been made to ensure that this TOR addresses all of the major issues associated with development proposal, they are not necessarily exhaustive. They should not be interpreted as excluding from consideration matters deemed to be significant but not incorporated in them, or matters currently unforeseen, that emerge as important or significant from environmental studies, or otherwise, during the course of preparation of the EIA report

1. **Introduction and rationale** –Describe the purpose of the project and, if applicable, the background information of the project/activity and the tasks already completed.Objectives of the development activities should be specific and if possible quantified. Define the arrangements required for the environmental assessment including how work carried out under this contract is linked to other activities that are carried out or that is being carried out within the project boundary. Identify the donors and the institutional arrangements relevant to this project. .

2. **Study area** – – Submit a minimumA3 size scaled plan with indications of all the proposed infrastructures. Specify the agreed boundaries of the study area for the environmental impact assessment highlighting the proposed development location and size. The study area should include adjacent or remote areas,such asrelevant developments and nearby environmentally sensitive sites (e.g. coral reef, sea grass, mangroves, marine protected areas, special birds site, sensitive species nursery and feeding grounds).Relevant developments in the areas must also be addressed including residential areas, all economic ventures and cultural sites

3. **Scope of work**– Identify and number tasks of the project including preparation, construction and decommissioning phases.

Task 1. Description of the proposed project – Provide a full description and justification of the relevant parts of the project, using maps at appropriate scales where necessary. The following should be provided (all inputs and outputs related to the proposed activities shall be justified):
The main activities of the agriculture ralted development are:

- Dredging of an access channel is 425m long and 15m wide and a 50x50m habour to have a minimum depth of -3m at low tide
- Reclaimation/Development of a causeway between Hulhuvaarulaa and Menthanduvaa using dredged material

Environmental Protection Agency
Green Building, 3rd Floor, HandhuvareeHingun
Male', Rep. of Maldives, 20392
Tel: [+960] 333 5949 [+960] 333 5951
Fax: [+960] 333 5953
Email: secretariat@epa.gov.mv
Website: www.epa.gov.mv

- Land clearance for temporary and permanent facilities construction ;
- Development Solar power for Energy system,
- Rainwater harvesting system,
- Development of cold deep sea water system for Cooling green houses
- Infrastructure construction including power house, oil storage tanks, waste management facility staff accommodation etc.;
- 4 hectares of advanced hydroponic greenhouses in phase One (Approximately 10 hectares of land clearance in GDh. Hlhuvaarulaa)
- Clearance of 11 hectares of land for green house development in Phase two (7 Hectares from Hulhuvaarulaa and 5 hectares from Menthanduaa and Golhaalaa)
- Construction and operation of accommodation, green houses and other facilities(include an A3 land use map with boundaries);
- Environmental monitoring during construction activities;
- Measures to protect environmental values during construction and operation phase;
- Project management (include scheduling and duration of the project and life span of facilities; communication of construction details, progress, target dates, construction/operation/closure of labour camps, access to site, safety, equipment and material storage, fuel management and emergency plan in case of spills)

Land clearance:

- Define the total area of cleared vegetation and earthworks;
- Methods of clearance and vegetation waste disposal.

Channel, harbour and lagoon area:

- Location and size of channel on a map;
- Justification for the selection of these locations;
- Labour requirements and (local) labour availability;
- Emergency plan in case of spills (diesel, grease, oil)

Type of crops

- Identify types of crops that will be grown in the green houses, required optimum time for growth, seasonal variations
- Type of fertilizers or chemicals to be used
- Volume of crop production

The EIA report should investigate possibilities for alternatives:

- Operation and positioning options;
- Alternative areas for disposal of dredged material, and
- Alternatives for causeway construction.

Deep sea water cooling system:

- Location, quantities, technology and monitoring system;
- Describe equipment needed and construction methods for laying the offshore pipeline including handling transportation etc

- Pipeline construction methods, scheduling and drawings;
- Justification for the location of the water intake and outfall pipelines;
- Emergency plans.

Power supply and backup plant and oil storage:
- Location and size of backup generators and facility;
- Fuel transportation technique and volume required;
- Emergency power supply plan;
- Low energy consumption ventures and awareness.

Sewerage plant:
- Plant location, capacity and justification;
- Sewerage systems
- Identify potential alternative locations with minimal impacts
- Specify an emergency plan if system fails.

Waste management facility:
- Location justification, carrying capacity, materials to be collected and equipment required for waste reduction and recycling;
- Transportation mechanisms and costs;
- Recycling ventures and awareness activities within the resort

Temporary facilities:
- Construction methods, scheduling and operation of temporary facilities including power generation, oil storage, water supply, waste water treatment, accommodation facilities, waste management and decommissioning.

Task 2. Description of the environment – Assemble, evaluate and present the environmental baseline study/data regarding the study area and timing of the project(e.g. monsoon season). Identify baseline data gaps and identify studies and the level of detail to be carried out by consultant. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that data collected is suitable for use as a baseline. As such all baseline data must be presented in such a way that they will be usefully applied to future monitoring. The report should outline detailed methodology of data collection utilized.

The baseline data will be collected before construction and from at least two benchmarks. All survey locations shall be referenced with Geographic Positioning System (GPS) including water sampling points, reef transects, vegetation transects and manta tows sites for posterior data comparison. Information should be divided into the categories shown below:

Climate
- Temperature, rainfall, wind, waves, evaporation rates (including extreme conditions)
- Risk of flooding and storm surges;

Environmental Protection Agency
Green Building, 3rd Floor, HandhuvareeHingun
Male', Rep. of Maldives, 20392
Tel: [+960] 333 5949 [+960] 333 5951
Fax: [+960] 333 5953
Email: secretariat@epa.gov.mv
Website: www.epa.gov.mv

Geology and geomorphology

- Offshore/coastal geology and geomorphology (use maps);
- Bathymetry (bottom morphology) (use maps);
- (Seasonal) patterns of coastal erosion and accretion (see appendix for monitoring details), and
- Characteristics of seabed sediments to assess direct habitat destruction and turbidity impacts during construction;

Hydrography/hydrodynamics (use maps)

- Tidal ranges and tidal currents;
- Wave climate and wave induced currents;
- Wind induced (seasonal) currents;
- Sea water quality measuring these parameters: temperature, pH, salinity, turbidity, Total Suspended Solids (TSS), phosphate, nitrate, ammonia, sulphate, BOD and COD.

Marine and terrestrial Ecology

- Identify marine and coastal areas and sensitive sites such as breeding or nursery grounds for protected or endangered species (e.g. coral reefs, spawning fish sites, nurseries for crustaceans or specific sites for marine mammals, sharks and turtles). Include description of commercial species, species with potential to become nuisances or vector.
- Benthic and fish community monitoring around the islands particularly in all impact zones
- Landscape integrity, and description of the island vegetation, detailed of vegetation to be cleared
- Groundwater quality measuring these parameters: Temperature, pH, Salinity, Electrical Conductivity, nitrates, phosphates, ammonia, sulphates, faecal coliform, total coliform and Hydrocarbons. (Groundwater quality should be tested from at least 05 different locations)

Natural hazard and vulnerability

- Vulnerability of the area to flooding and storm surges

Socio-economic environment

- Demography: total population, sex ratio, density, growth and pressure on land and marine resources;
- Income situation and distribution
- Economic activities of both men and women (e.g. fisheries, home gardening, fish processing, employment in industry, government);
- Seasonal changes in activities;
- Land use planning, natural resource use and zoning of activities at sea;
- Accessibility and (public) transport to other island;
- Services quality and accessibility (water supply, waste/water disposal, energy supply, social services like health and education);
- Community needs;
- Sites with historical or cultural interest or sacred places (mosques, graveyard).

Task 3. Legislative and regulatory considerations – Identify the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project. The EIA report should clearly identify the different applicable clauses and articles of the legislative and regulatory requirements. Include permits and approvals in the EIA document:

- Law of leased islands ought to be consulted
- All Pesticides and fertilizers ought to be approved by MoFA
- Species crops to be approved by MoFA

Task 4. Potential impacts (environmental and socio-cultural) of proposed project, incl. all stages – The EIA report should identify all the impacts, direct and indirect, during and after construction, and evaluate the magnitude and significance of each. Particular attention shall be given to impacts associated with the following:

Impacts on the natural environment

- Terrestrial impacts; impact on ground water table, loss of terrestrial vegetation and fauna from land clearance works;
- Impacts on marine habitats: including damages to coral reefs and seagrass communities, fish stocks, protected areas and protected species;
- Impact from dredging and reclamation: Changes in erosion/sedimentation patterns, which may impact shore zone configuration/coastal morphology;
- Temporary sediment dispersal in water column (turbidity at the dredging site, reclamation areas and related to shore protection activities), possibly resulting in changes in visibility, smothering of coral reefs and benthic communities and affecting fish and shellfish etc.;
- Impact on nearby MPAs or sensitive areas
- Impacts on landscape integrity/scenery.

Impacts on the socio-economic environment

-
- Impact on food prices and availability
- Impact of intense organic material or other resource users e.g. Fisheries, tourism industry
- Impacts on employment and income, potential for local people to have (temporary or long term) job opportunities (and what kind) in the execution of the works;
- Disturbance to local natural resource users such as fishing areas, other tourism ventures;
- Impacts to nearby resorts and dive sites;
- Level of protection against hazards like sea level rise, storm surges, etc.
- Impact equity (economic activities, employment, income);
- Impacts on accessibility and transportation of goods to island.
- Social destabilisation of the island community

Construction related hazards and risks

- Pollution of the natural environment (e.g. oil spills, discharge of untreated waste water and solid waste, including construction waste);
- Risk of accidents and pollution on workers and local population.

The methods used to identify the significance of the impacts shall be outlined. The report should outline the uncertainties in impact prediction and also outline all positive and negative/short and long-term impacts. Identify impacts that are cumulative and unavoidable. Use interaction matrices (e.g. Leopold Matrix) to assess the magnitude and significance of the impacts.

Task 5. Alternatives to proposed project – Describe alternatives including the *"no action option"*should be presented. Determine the best practical environmental options. Alternatives examined for the proposed project that would achieve the same objective including the "no action alternative". The report should highlight how the location was determined. All alternatives must be compared according to international standards and commonly accepted standards as much as possible. The comparison should yield the preferred alternative for implementation. Mitigation options should be specified for each component of the proposed project.

Task 6. Mitigation and management of negative impacts – Identify possible measures to prevent or reduce significant negative impacts to acceptable levels. These will include both environmental and socio-economic mitigation measures. Mitigation measures to avoid or compensate habitat destruction, e.g. temporal sediment control structures, coastal protection structures to reduce erosion, coral reconstruction and MPA replacement areas. Measures for both construction and operation phase shall be identified. Cost the mitigation measures, equipment and resources required to implement those measures. The confirmation of commitment of the developer to implement the proposed mitigation measures shall also be included. An Environmental management plan for the proposed project, identifying responsible persons, their duties and commitments shall also be given. In cases where impacts are unavoidable arrangements to compensate for the environmental effect shall be given.

Task 7. Development of monitoring plan– Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan for coastal modification, beach morphology, sediment movement around the island. Ecological monitoring will be submitted to the EPA to evaluate the damages during construction, after project completion and every three months thereafter, up to one year and then on a yearly basis for five years after. The baseline study described in task 2 of section 2 of this document is required for data comparison. Detail of the monitoring program including the physical and biological parameters for monitoring, cost commitment from responsible person to conduct monitoring in the form of a commitment letter, detailed reporting scheduling, costs and methods of undertaking the monitoring program must be provided.

Task 8. Stakeholder consultation – Identify appropriate mechanisms for providing information on the agricultural project to relevant stakeholders, government authorities. In this respect consultation shall be undertaken with the following stakeholders and any other relevant stakeholders identified during the preparation of the EIA report:

- GDh. Gahdhoo Council
- GDh. Atoll Council
- Ministry of Fisheries and Agriculture
- Maldives Food and Drug Authority

Details of the consultative meetings including summary outcomes, participants, date, time and location should be described. The EIA report should include a list of people/groups consulted, their contact details and summary of the major outcomes. The EIA report should be submitted to the atoll council and evidence of which included in the EIA report.

Presentation- The environmental impact assessment report, to be presented in digital format, will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations f or any references used in interpreting those data. The environmental assessment report will be organized according to, but not necessarily limited by, the outline given in the Environmental Impact Assessment Regulations, 2012 and the relevant amendments.

Timeframe for submitting the EIA report – The developer must submit the completed EIA report within 8 months from the date of this Term of Reference.

27th December 2015

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މާލެ، ދިވެހިރާއްޖެ

Ministry of Fisheries and Agriculture

Male', Republic of Maldives

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29 އެޕްރީލް 2015

(signature)

ހުސައިން ރަޝީދު

ޑެޕިއުޓީ މިނިސްޓަރ އޮފް ފިޝަރީޒް އެންޑް އެގްރިކަލްޗަރ

ހަމީދާގެ ބޯއި ޕްރޮޕަރޓީޒް ލިމިޓެޑް
މާލެ، ދިވެހިރާއްޖެ

ވެލާނާގެ، 7 ވަނަ ފަންގިފިލާ،
އަމީރު އަޙްމަދު މަގު، މާލެ، 20096، ދިވެހިރާއްޖެ

Velaanaage, 7th Floor,
Ameeru Ahmed Magu, Male', 20096, Republic of Maldives
(+960) 332 2625 | (+960) 332 6558 | www.fishagri.gov.mv | admin@fishagri.gov.mv | fishagri

Annex 3: Landuse plan and concept design

GDh Hulhuvaarulaa Access Channel and Harbor development PROJECT BRIEF

1. INTRODUCTION

A cluster of four islands (GDh Hulhuvaarulaa, Golhaalaa, Menthandhoo and Dhoonirehaa) located within the house reef of GDh Gadhdhoo, has been leased by the Ministry of Fisheries and Agriculture to Hummingboy Farms Pvt. Ltd. for agriculture related developments. To gain access, loading/unloading, for the four islands the company is proposing to excavate a channel and a harbour on GDh. Hulhuvaalurlaa Island and use the dredged material for backfilling harbor protection structures and the excess material to reclaim a causeway between Hulhuvaarulaa and Menthanduvaa. Estimated reclamation area from western side is approximately 20,571 sqm. Total length of the channel is 425m and the width is 15m and the harbor is 50x50m. The channel and the harbor will be dredged to have a minimum depth of -3m at low tide. Estimated volume of material that will result from channel dredging is approximately 19,125 cbm and from harbour 7500 cbm making the total volume of dredged material 26,625 cbm. Dredged material will be used as backfill for harbour protection structure and the excess for island leveling related work.

2. SCOPE OF WORK

Preliminary works

a. Obtaining environmental permissions to conduct the EIA report and execute the works by a contractor

Mobilization of all resources required by the contractor to execute the works

a. Preparation of marine equipment for sailing,
b. Insurance inspections for the marine equipment,
c. Mobilization of the marine spread and land equipment to site.
d. Mobilization of land based equipment (Bull dozers, excavators, wheel loaders, generators, etc.)

Preparatory site works

a. Preparation of all marine equipment for operations,
b. Mobilization and installation of marine and land equipment, workers lodging and accommodation
c. Conduct a pre dredging hydrographic survey of the channel and harbor area.

Dredging and reclamation works (see attached preliminary dredge and fill plan)

a. Excavation of the channel to maintain a minimum depth of -3.0m at low tide.
b. Material excavated will be used for backfill harbor protection and for leveling work.
c. Construction of sandbeds for excavator path at the outer margin of the dredging area followed by a mesh screen to contain the sediment and minimize spreading of sediment plume. Sandbed will be removed as the excavator retreats back to the shoreline.

Finalization works

a. Conduct a pre dredging hydrographic survey of the dredged areas and confirm the required lines and levels.
b. Removal of all installations
c. Prepare all equipment for demobilization.

3. PLANTS AND EQUIPMENTS

The following equipment is earmarked for the dredging and discharging scope of work as described:

Marine based

a. 1 no. work boat,
b. 1 no. multicat / crane barge.

Land based items

c. Bulldozer capacity (1 Caterpillar D6 LPG or similar)
d. Wheel loader capacity (1 Caterpillar 950 or similar)
e. Excavator capacity (2 Caterpillar 320 or similar)

General

a. Dredging and discharging crew and staff
i. Site management 2 pax
ii. Excavator operating staff 3 pax
iii. Junior staff crew 8 pax
iv. Berge crew personnel 4 pax
Survey, control and monitoring equipment or similar

4. ENVIRONMENTAL CONSIDERATIONS

Compared to the scale of island access and harbor development projects in the Maldives this project is relatively small. The involved quantities will be around 26,625m^3. Due to its small size it is expected that the project will not have a noticeable negative impact on the environment. The project duration is only a couple of months and this will guarantee that the surrounding areas will not be affected at all by the unavoidable temporary increase in turbidity levels related to the dredging works.

The project is expected to significantly enhance the operations associated with the island as this would get easy marine access for vessels and other marine equipment also the development will establish connection between the four islands. This development is likely to increase the productivity of the island and contribute to the local economic prosperity.

5. PROGRAMME OF WORKS

The following durations and work programme can be considered:

- Obtaining approvals to commence and execute the works ~1 month
- Preliminary works , contract finalization, accommodation setup ~2 weeks
- Mobilization of all resources required to execute the works ~1 week
- Dredging the access channel and the harbor basin to -3.0m at low tide ~2 months
- Post dredging survey ~1 week

Note that above durations are indicative and are subject to actual seabed and site conditions encountered at the time of execution of the scope of work, the availability and suitability of dredging and discharging areas and the overall quantity of material to be dredged and filled.

……..

Figure-1 Hulhuvaarulaa Islands outline before development

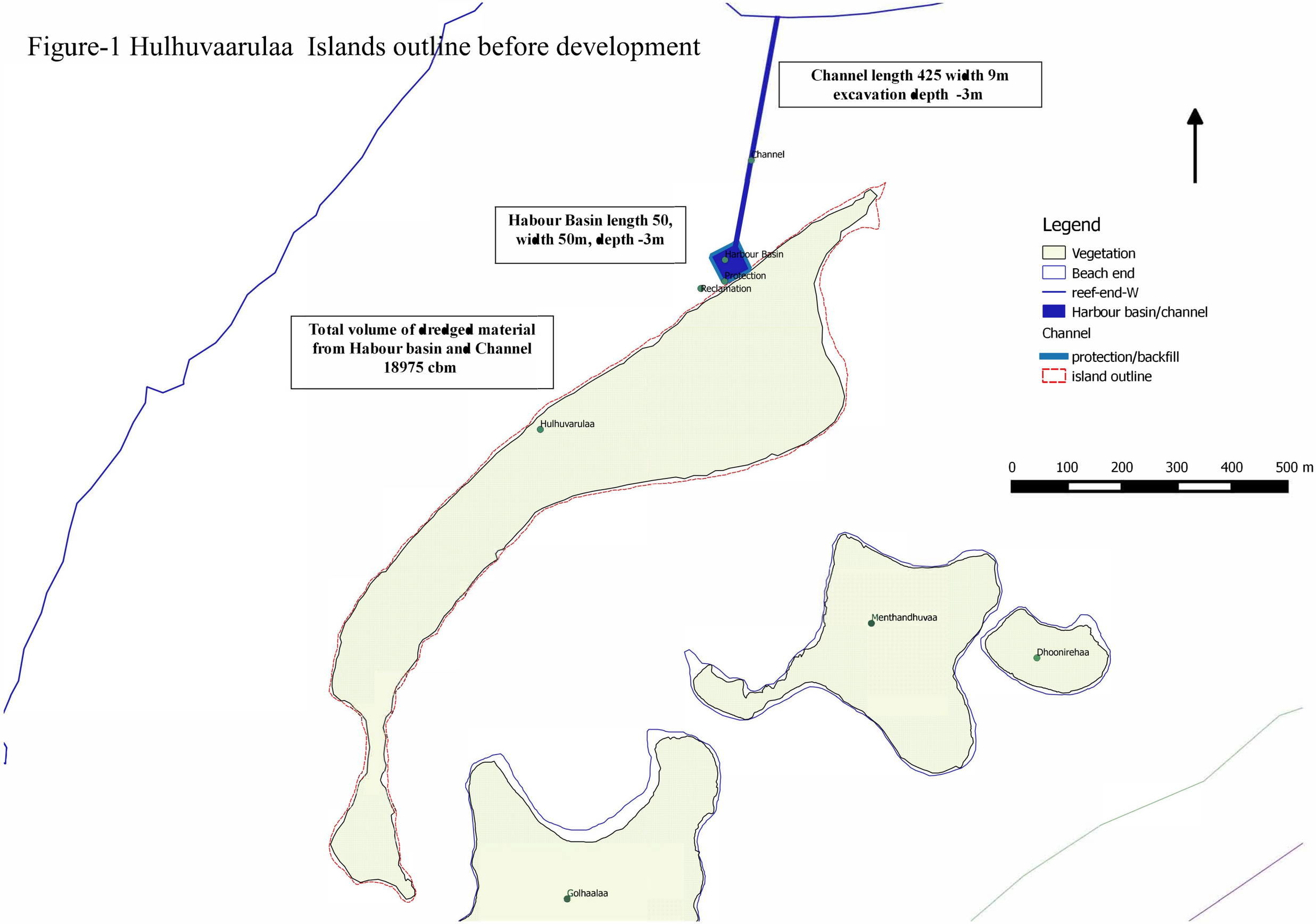
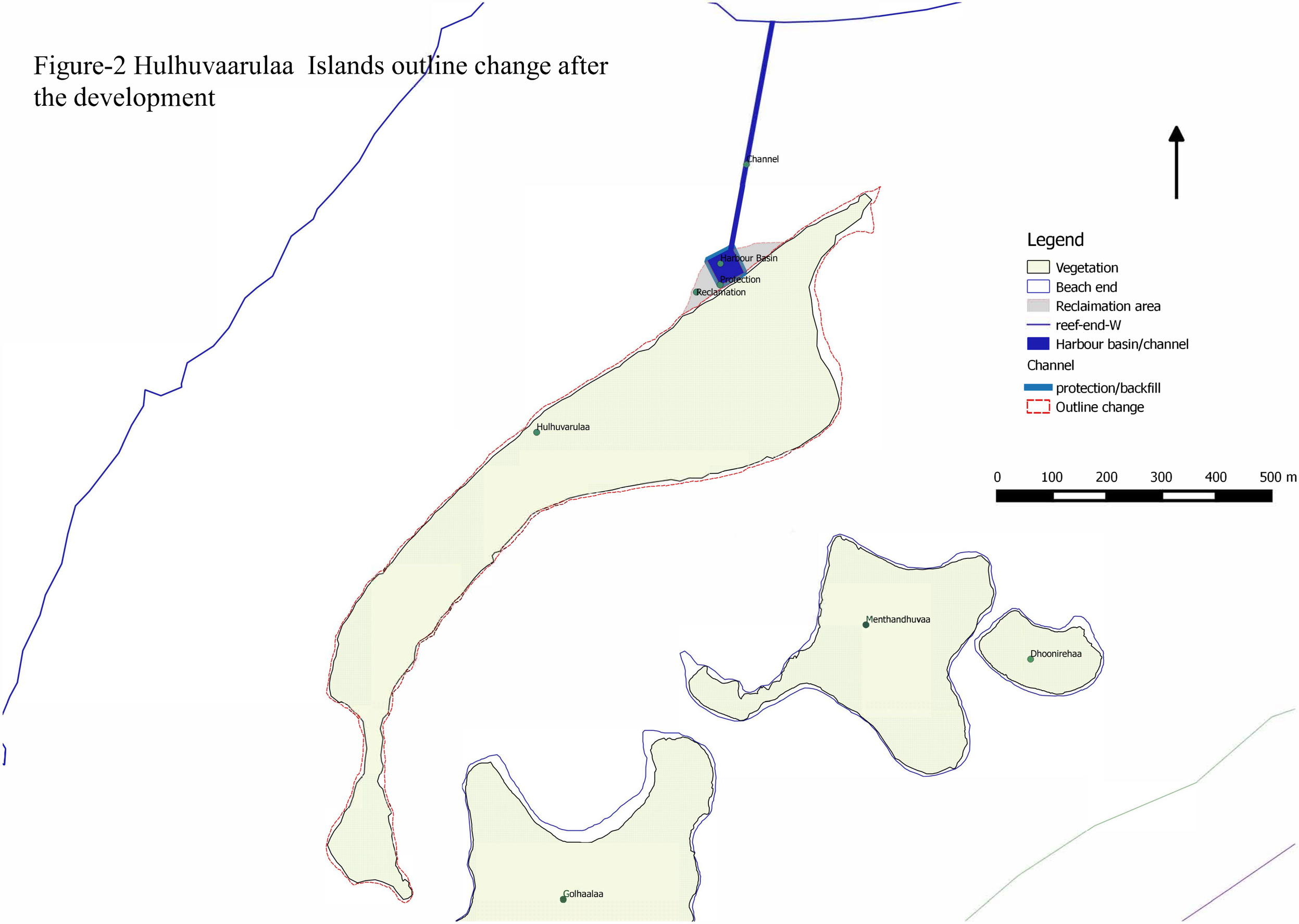


Figure-2 Hulhuvaarulaa Islands outline change after the development



Ministry of Environment and Energy
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Environmental Protection Agency
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1 [illegible]

[illegible]: Hummingboy Farms Pvt. Ltd (David Anderson)

[illegible]: ([illegible])

[illegible]: M. Kudaveyomatherge, Hummingboy Farms Pvt. Ltd.

[illegible]: Subdhelimagu, Male 20315

[illegible]: davidab@hummingboy.com

[illegible]: +960 7844183 [illegible]

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HUMMINGBOY FARMS
C-0239/2013

[illegible]:

2 [illegible]

[illegible]: Hummingboat Farms Pvt.Ltd (agriculture development in Maldives)

[illegible]:

GDh Hulhuvaarulaa, Golhaalaa, Menthandavaa and Doonizehaa have been leased by the MoFA to Hummingboy Farms Pvt. Ltd. for agriculture related developments. To gain access for the four islands the company is proposing to excavate a channel and a harbour on GDh. Hulhuvaaharlaa Island and use the dredged material for backfilling harbor protection structures and the excess to reclaim a causeway between Hulhuvaarulaa and Menthaduvaa. Total length of the channel is 425m and the width is 15m and the harbor is 50x50m to a minimum depth of -3m, estimated volume of dredged material from the dredging is 26,625 cbm.

[illegible]:

The islands are leased by MoFA with the provision to develop necessary infrastructure required for the proposed project

[illegible]: year 1

[illegible]

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Annex 5: Leopold matrix of HBF agriculture development project

			Construction Phase													Operational phase										
			Activity																						
			Mobilization of Equipment and Labour	Vegetation Clearance	Harbour, access channel dredging & reclamation	Seawater cooling system	Advanced hydroponic greenhouses	Solar power grid for Energy system	Fuel storage	Earthwork and levelling	Heavy vehicle operation, noise, air quality dust	Sewage and litter management	installation of utilities	Rainwater harvesting & condensate water collection	material stock pilling	Fuel and chemical storage handling and use	solid waste management	Equipment & vehicle maintanace	Staff training	Water and electricity demand	Agriculture farm operations	Sewage disposal	Harbour operations and transportations	Total	
I- Physical and Chemical Chracteristics	1.Land	a.Soil	2 4	9 9	3 5		2 4	4 5	3 4	6 6	4 5	5 5	5 7		5 4	1 4	2 3	1 1	+4 4		1 2			49	62
		b. landscape	1 2	7 9			4 6	4 5		6 6	2 2	3 1	2 4		4 5	2 3	2 3		+4 4		3 4			36	46
	2.Water	water table contamination	4 5	5 5	2 2		1 2		2 3	5 5		5 2	3 3	+10 8	5 5	2 3	3 4	2 2		+5 5	1 2			25	30
		interaction with surface driniage	2 4	5 7						5 6	4 3	2 1	3 3	3 3	5 6		4 4	2 2			2 1			37	40
		change in water quality	1 2	5 6						4 5	3 1	5 2	2 2	+9 7	6 7	3 3	5 5	1 2	+4 4	+5 5	1 2			18	21
		runoff characersitics	2 2	6 7	2 5					6 5	2 2	1 1	2 2	+3 2	7 5		3 2				1 1			49	30
	3. Amosphare	a. air quality (gases, aerosol)	4 5					+4 5	5 6	5 5	4 5	3 3	3 3		5 5	2 3	3 3	2 3	+4 4	4 3	1 1		3 2	33	38
		b. Climate		2 5					5 5	3 2										+8 7	+8 7			+6	+2
II-Biological Conditions	1. Coastal and Marine Resources	a.current sediment dynamics			9 10	3 5													+4 4		3 3	+2 2	5 4	14	16
		b.lagoon water quality (turbidity)			10 6	2 3				1 1		4 3				2 2	3 4	3 3	+4 4		2 3	+3 3	5 4	25	22
		c. coral	1 4		10 6	5 2						3 2							+4 4		2 1		3 1	20	12
		d.sandy bottom creatures		7 8	10 6	5 2					2 3	3 2	2 2								2 3	+3 3	2 1	22	25
		e. beaches	4 5	5 7	10 6	2 2					4 5	2 2	1 2		5 5	3 3	3 3	3 3	+4 4		3 2	+3 3	4 4	42	42
		f. fish and fisheries			7 8																1 1			8	9
		g. Endangered species			7 8																			7	8
	2. Flora	a.trees, shrubs, grass	5 6	9 10		1 1		7 8		6 6	7 7	4 2	2 3	+3 4	6 7	3 3	4 4	4 3	+4 4	+5 5	3 3			49	50
		b. endangered species		5 8				5 6		5 5	3 3	1 1			3 4				+4 4		+5 5			13	18
	3.Fauna	a. birds land animals, reptiles		8 9		2 3	2 3	7 8		7 7	5 5	2 2	3 4		6 5		2 1	3 3			+5 5			42	45
		b. insects		8 9		1 2	2 3	4 5		7 7	5 5	3 3			6 7		5 4	4 4	+4 4		3 2	2 2		45	49
		c. Endangered species		4 8			2 3			3 2											+5 5			4	8
III- Aesthtics, Cultural & socio-economic Condition	1. Aesthetics and Human	a.Scenic view and vistas	6 7	10 5	5 7	3 4	6 7	7 6	6 5	6 4	6 5		4 4	3 3	7 6	4 5	6 5	5 4		3 2	3 2	3 3	4 4	97	91
		b.noise/vibration	7 7		4 6	4 5		+3 4	3 4	6 6	7 3	2 2	5 6	4 3	4 5	3 3	3 4	2 3	+4 4	2 1	4 3		3 2	61	63
		c.litter/debris/dust	7 7	8 9	4 6	3 4	1 1			6 7	7 3		5 5	1 1	7 7	1 3	6 6	4 4		2 2	4 4	3 3	5 4	67	76
		d.ordour	2 1		4 4				6 6	2 1	5 2		6 6		7 7	4 3	6 5	5 3		1 1	3 3	4 4	1 1	56	56
		e.Wildness qualities		5 7			3 3	6 7		3 4	3 1		1 2						+4 4		+5 5			12	15
		f.Open space qualities		7 8			4 4	7 7	6 6	4 4	1 1			4 5	6 6	4 4	6 6	4 2		2 2	3 3	4 3	3 2	65	63
		g.landscape design		7 8		1 1	5 5	7 7		4 3	1 1		3 3	3 2	5 6		3 4				3 4		1 1	43	42
	2. Cultural Status	a. cultural patterns lifestyles			+4 5		5 6	+6 6			2 3		3 3	+5 4					+4 4		+6 5		+2 2	+17	+14
		b. health and safety	+3 5				+3 2	+6 6	6 6	5 6	3 3		+5 5	+5 5	5 5	5 5	5 5	3 3	+4 4	3 2	+6 5	3 1	+3 3	+2	1
		c. Employment	+6 7	+3 8	+4 5	+2 3	+3 4	+8 7	+6 7	+6 6	+6 6		+6 6	+4 4	+6 6	+5 5	+5 5	+5 5	+7 4	+4 3	+10 10		+6 6	+87	+101
	economic	bussiness oppertunities	+7 8	+9 9		+2 3	+7 8	+8 8	+7 7	+6 6	+5 5		+6 6	+5 4	+6 6	+5 5	+5 6	+5 6	+5 5	+5 6	+2 4		+9 9	+104	+103
		Total	32 41	102 127	69 73	28 28	24 33	25 30	31 31	93 90	69 57	48 33	43 45	+26 +21	92 95	29 37	64 64	38 34	+73 73	+6 18	+7 +2	8 5	19 10		

Key M / I

I = Importance

M=Magnetude

Male' Water & Sewerage Company Pvt Ltd
Water Quality Assurance Laboratory
FEN Building 5th Floor, Machangoalhi, Ameeneemagu, Male', Maldives
Tel: +9603323209, Fax: +9603324306, Email: wqa@mwsc.com.mv

بسم الله الرحمن الرحيم

MWSC

WATER QUALITY TEST REPORT

Test Report No: 301226/2016/01

Customer Informations : ***Mr. Mahmood Riyaz***
H. Hithifaiy,
Hithah Finivaa magu,
Male'
Rep.of Maldives

Date: 28/02/2016

Sample Description / Location~	Ground Water Golhaalaa	Hulhuivaavula GW	GW Menthandhoo	TEST METHOD	UNIT
Sample Type~	Ground water				
Sampled Date~	30/1/2016				
Sample Received Date	25/2/2016				
Test Requisition Form No.	900162976				
Sample No.	821976	821977	821978		
Date of Analysis	25/2/2016 -27/2/2016				
PARAMETER	ANALYSIS RESULT				
Physical Appearance	Clear	Clear	Clear	Visual	-
pH	7.22	7.20	7.30	Method 4500-H+ B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	-
Nitrite	0.018	0.014	0.011	Method 8507 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Nitrogen Ammonia	0.34	0.38	0.24	Method 8038 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Sulphate	<10 (LoQ 10mg/L)	<10 (LoQ 10mg/L)	18	Method 8051 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Salinity	0.34	0.29	0.36	Method 2520 B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	‰
Phosphate	0.07	1.25	<0.05 (LoQ 0.05mg/L)	Method 8048 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Temperature	22.7	21.7	21.4	Electrometry	°C
Total Dissolved Solids	347	304	368	Electrometry	mg/L

Keys:
‰: Parts Per Thousand, **mg/L:** Milligram Per Liter, **°C:** Degree Celcius
LoQ: Limit of Quantification

Checked by:	Approved by:
Afnan Farooq Laboratory Executive	Abdulla Rasheed Senior Quality Officer

Notes:
Sampling Authority: Sampling was not done by MWSC Laboratory
This report shall not be reproduced except in full, without written approval of MWSC
This test report is ONLY FOR THE SAMPLES TESTED.
~ Information Supplied by the customer

**********END OF THE REPORT**********

Male' Water & Sewerage Company Pvt Ltd
Water Quality Assurance Laboratory
FEN Building 5th Floor, Machangoalhi, Ameeneemagu, Male', Maldives
Tel: +9603323209, Fax: +9603324306, Email: wqa@mwsc.com.mv

بسم الله الرحمن الرحيم

WATER QUALITY TEST REPORT

Test Report No: 301226/2016/02

Customer Informations : ***Mr. Mahmood Riyaz***
H. Hithifaiy,
Hithah Finivaa magu,
Male'
Rep.of Maldives

Date: 28/02/2016

Sample Description / Location~	Pipeline area Sea Water	Lagoon Water Sea Water	TEST METHOD	UNIT
Sample Type~	Sea water			
Sampled Date~	30/1/2016			
Sample Received Date	25/2/2016			
Test Requisition Form No.	900162976			
Sample No.	821979	821980		
Date of Analysis	25/2/2016 -27/2/2016			
PARAMETER	**ANALYSIS RESULT**			
Physical Appearance	Clear	Clear	Visual	-
pH	7.22	8.19	Method 4500-H+ B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	-
Sulphate	3000	2900	Method 8051 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Salinity	35.31	34.80	Method 2520 B. (adapted from Standard methods for the examintation of water and waste water, 21st edition)	‰
Phosphate	0.07	0.07	Method 8048 (Adapted from HACH DR5000 Spectrophotometer procedure Manual)	mg/L
Temperature	22.5	22.6	Electrometry	°C
Total Dissolved Solids	26800	26406	Electrometry	mg/L

Keys:
‰: Parts Per Thousand, **mg/L:** Milligram Per Liter, **°C:** Degree Celcius
LoQ: Limit of Quantification

Checked by:	Approved by:
Afnan Farooq Laboratory Executive	Abdulla Rasheed Senior Quality Officer

Notes:
Sampling Authority: Sampling was not done by MWSC Laboratory
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This test report is ONLY FOR THE SAMPLES TESTED.
~ Information Supplied by the customer

**********END OF THE REPORT**********

HUMMINGBOY FARM

Our Ref: HBFEIA01

10th August, 2016

Mr. Thoriq Ibrahim
The Minister
Ministry of Environment and Energy
Ameenee Magu, Maafannu,
Malé-20392 , Republic of Maldives

Dear Mr. Ibrahim,

Re: PROPOSED AGRICULTURE DEVELOPMENT IN GDH. HUDHUVAARULAA, MENTHANDUAA GOLHAALAA AND DHOONIREHAA, GAAF DHAALU ATOLL

As the proponent responsible for environmental compliance for the above project, I hereby give our financial commitment to implement the monitoring plan, undertake the mitigation measures recommended and to comply with the issues identified in the Environmental Impact Assessment Report submitted to your agency.

Yours sincerely,

David Anderson
Hummingboy Farms Pvt. Ltd.

HUMMINGBOY FARMS
C-0225/2013

ފޯ: ގައުމީ ކަންތައް ބަލައިގަންނަ ތަނުގެ ތެރޭގައި

ފޯ: ގައުމީ

ފިލުވާ ހިންގުމުގެ

ނަންބަރ: //-

ވާދޫ ސަލާމަތާ ދެކޮ ގަދަ ގަމާ

ތަރައްގީ ހިންގުމާ ގުޅޭ ބަލައިގަތުން

Environmental Impact Assessment for agriculture development in Gdh. Hudhuvaarulaa, MenthanduaaGolhaalaa and Dhoonirehaa, GaafDhaalu Atoll

ބަލައިގަންނަ ގަމުގެ ނަން: ހުދުވާރުލާ، ހުދުވާ ގޮތާ، ދޫނިރެހާ

ގަޑުގަ: ހުދުވާ ސިއްކަ ދީގެ ކުރިމަ

ތަރުޖަމާ ކުރާ ނަން: ހަސަން ޝަމްޢޫން ގައްދާރު

ތާރީޚް: 14 ނޮވެމްބަ 2016 ގަޔާ: 10:15

ސޮއި

ތަރުޖަމާ ކުރާ ގޮތް ކަށަވަރު ކުރާ ފަރާތް

11 ނޮވެމްބަ 2016

Annex 9: Stakeholder consultation, scoping meeting and public consultation attendance

Environmental Protection Agency
Male', Rep of Maldives

Meeting: Scoping Meeting ~~Gdh~~ Hummingboy farms Agriculture Development at Gdh. Atoll 4 Islands.

Date: 27-12-2015

Time: 10:00 am.

MEETING ATTENDANCE

	Name	Designation	Office	Email	Phone No.	Signature
01	MOHAMED RIZAN	ATOLL COUNCILLOR	GDH ATOLL COUNCIL	mohamed.rizan@myself.com	7781672	[signature]
02	ABDULLA SADHIQ	COUNCELOR/GADHDHOO	GADHDHOO COUNCIL	abdhullasadhiq@gmail.com	7781721	[signature]
03	Abdulla Naseer	EIA/consultant	–	abdhullah.naseer@gmail.com	7788197	[signature]
04	Ibrahim Falaah	Manager	Hummingboy farms	ibrahimfalaah@mac.com	7771385	[signature]
05	Mohammed Rizan	Consultant.	Freelance.		7870304	[signature]
06	Satheesh Moorthy	Senior Scientific Officer	MRDA	Satish@health.gov.mv	7970937	
07	Aminath Nithana	Project officer	MRDA			
08	Mohamed Raneez	S. Research officer	EPA	mohamed.raneez@epa.gov.mv	7850258	[signature]
09	Ahmed Anwar	Asst. Director	MEE			[signature]
10	Adam Mubeen	Asst. Engg.	EPA			[signature]
11	Nashwa Ahmed Manik	Envt. Analyst	EPA			[signature]
12.	Mohamed Hamdhaan Zubair	Assistant Director	EPA	mohamed.hamdhan@epa.gov.		[signature]

ae

(1) Faathumaa manike / Dhadikoshiuge

(2) hawwa manike. / koralgaaden

(3) Amindiye. / neveeload

(4) Sammeena Adam / Dhon bagei dhage

(5) Aishath Moosa. / deylige.

(6) Mariyam Zabeyra / Fandunelwaage.

(7) Shareefa / Dhilbahaaruge

(8) Mohamed Adam / sunlight Ville

(9) Mohamed Alio / AAhiyaage

(10) Mohamed Rasheed / hawalege

(11) Mohamed Ahmed / bulbulaage / irumathy

(12) Ahmed Moosa / seenuge

(13) Waheedha ismail / irumathge hawe

(14) Rameeza fahume / handuvaree naaz

(15) Aminath faanu. / Futtaruge

(16) kokaan / Hart.

(17) Mohamed Ismail. / zamaanee villa

(18) Ibrahim saukath / happysun

(19) Hassan habeeb / athiree Asseyri

20) Mohamed waheed / Futtaruge.
21) Ahmed Gazaal (wathaabe / dhanikoshige.
22) Faathmath Aneesa / munnaaruge
23) Aisath manike / kudhuuaage.
24) Nizaaru Ahmed / thinfiya.
25) Mohamed Hassan (Faro) / Furozge.
26) Abdul samadhu / noomaraage
25) Mohamed ubaidu. / gahuu
26) mohamed didi / kashikeyomaage
27) hassandidi. / kenareege.
28) Mohamed saeed / seena house.
29) Ibrahim Naseer / habaruge
30) Abdul raheem / chichandaage
31) Abdula Ibrahim / saaman Willa.
32) Saeedha / dholhabuge.
33) Mohamed Rasheed / femoraage
34) Ibrahim Ismail. / seeko.
35) Abdul rahumaan. / Abulaage
36) Mohamed kallo / Fenfiyaazuge.
37) Ali Zuhaa. / Golden house.
38) Ibraahim Niyaz / Rajeenuge
39)